THE SCIENCE TEACHER

VOLUME 28, NUMBER 5 · SEPTEMBER 1961

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THE SCIENCE TEACHER

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

Journal of the National Science Teachers Association
Volume 28, Number 5 • September 1961

We are pleased to receive *Planning for Excellence in High School Science.* It is an excellent supplement of worthwhile contributions to create an awareness of the nature of today's problems in science education and possible solutions of these.

LILLIAN M. PARROTT
Douglass High School
Baltimore, Maryland

I wish to thank you and your office for the courtesy of sending me a copy of *Planning for Excellence in High School Science.* I have read it word by word and think it a most excellent statement.

One stress in the statements I most appreciate. That is the emphasis that science is a human activity. This long and agonizing fight between "science" and "the humanities" is of the essence of human stupidity.

Each type of human activity has value. "Science," whatever it is, is as "humanistic"—by definition—as any activity within what we call "the humanities." And I say this as one who began his educational career as a "teacher of English."

Keep up the good work, if keeping up the good work means more and more of the quality of this publication.

DAVID H. BARNES
NEA, Research Division
Washington, D. C.

Thank you for your copy of the recent publication entitled, *Planning for Excellence in High School Science.* It has been my privilege to read portions of this publication, and I have found them realistic and practical in their application.

Best of all, however, this publication is written in "down to earth" language. It is my opinion that more professional organizations should follow the pattern of presenting their materials in a manner which can be understood by all literate persons who may wish to read them. This is a fine job.

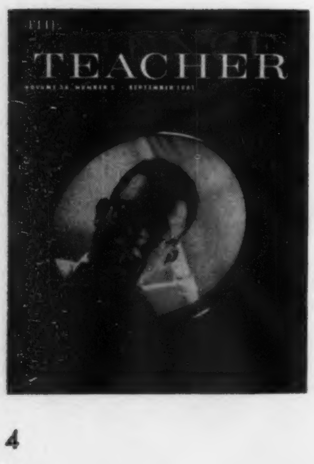
W. DALE CHISMORE
State Department
of Public Instruction
Des Moines, Iowa

Thank you very much for your thoughtfulness in sending to me a copy of *Planning for Excellence in High School Science.* Without question the leaders at your Conference addressed themselves to one of the most important problems facing our schools today. I feel confident that the excellence of your report will stimulate constructive thinking on every level.

CLAYTON E. ROSE
New York State
Teachers Association
Albany, New York

This is to acknowledge receipt of your complimentary copy of *Planning for Excellence in High School Science,* and other publications which we received at an earlier date. We hope to give some conference or workshop study this summer to the problem of developing a course of study in science. The bulletin will give us some guidance for this task.

R. C. ROBERTS
State Department of
Education
Jackson, Mississippi



THIS MONTH'S COVER . . .

The porthole of a germfree chamber in the laboratory replaces the traditional doorway in research experimentation. Through these "porthole" doors can be found unlimited opportunities leading to many health careers described fully in the lead article on page 6.

The "guinea-pig eyeview" looking out into the *world of germs* from the inside of the germfree equipment was caught by research photographer, Irving L. Bragg of the National Institutes of Health.

THE SCIENCE TEACHER

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* Includes the *Elementary School Science Bulletin* published monthly from September through April of each year.

Editorial

An examination of the NSTA seal reminds us that the National Science Teachers Association is comprised of people interested in science teaching at the elementary school, secondary school, and collegiate levels. Furthermore, that its members work to improve the professional status of science teachers and effectiveness of their efforts in teaching science.

The record of NSTA accomplishments is one to which we can point with considerable pride. Membership has increased from 1745 in 1945 to 16,000 in 1961. Comparisons of NSTA's annual budgets over the fifteen-year period show that the extensiveness of activities and magnitude of NSTA operations have grown proportionately. Its growth record clearly indicates that NSTA is no longer a struggling infant. In fact it is rapidly completing the years of its adolescent development. During the next few years it must make new decisions, important decisions. These decisions may well determine its future stature as a professional Association, which is truly representative of the nation's science teachers who must go forward in ways that will serve the best interests of their profession.

Although our membership is made up of elementary school teachers, secondary school teachers, college teachers, supervisors, administrators, educators, and representatives from business and industry, we are joined together in the NSTA enterprise with one common interest, the improvement of science teaching in schools and colleges. We are concerned not only with how the Association can serve us as individuals but, more important, how we as individuals can better serve the science education profession through our Association.

Never has there been greater national concern about the improvement of science teaching. Never have there been so many interested groups wanting to help. Within the membership of our Association, we have the ultimate means for getting the job done; for we are the science teachers of America. Furthermore, we have the potential power to define the ends and give effective direction to the means. The power rests within our determination to get on with the job. In turn our stature as a professional Association will be determined by how we go about mobilizing and exercising this power. There are at least three ways in which NSTA must go forward vigorously and with clear vision of what can be done in the future.

The Association must strengthen its publications efforts. This must be done by carefully studying the needs that can be served best by this medium and then planning a long-term publications program accordingly. NSTA publications should be conceived within such order of significance and such quality of production that members will consider it a professional honor to contribute their talents in the work that it will take to produce them. The Association cannot attain professional prestige by continuing the policy of publishing materials only when and if opportunities with built-in financial aid come to the attention of its officers.

A second way in which the Association must move ahead is by doing more for the elementary school and college science teachers. The bulk of NSTA activities has been in secondary school science. A disproportionate emphasis upon the secondary school level is no doubt accounted for by the persistence of two assumptions:

1. Science in the schools should be studied primarily at the secondary school level.
2. College science teachers are highly trained specialists in their respective fields and, therefore, are exemplary teachers.

Today few, if any of us, consider these assumptions to be valid. At present the needs of elementary school and college science teachers may be more acute than those of secondary school science teachers, and NSTA should be doing more in these particular areas.

Finally, the Association should be working toward the development of clearly formulated policies regarding its position on current issues and problems in science teaching. This should be done wherever evidence warrants such definite commitments. Where the evidence is lacking or incomplete the Association should strongly support appropriate research. Once policies are formulated directions for effective action should be delineated. The Association must no longer be satisfied with the practice of improving policies to meet specific issues and problems as they are encountered. Nor should its activities be limited to short-term chores for agencies with special interests in science teaching.

It is proposed that in the year ahead we should make substantial progress in the three proposals described. More immediately, during 1961-62, we should focus attention upon the most critical phenomenon with which we as teachers must work, *the learner*. It may be that in our recent all-out efforts to update and upgrade science teaching we have become so preoccupied with the science phenomenon that we have lost sight of the learner. Efforts to improve science teaching exclusively by increasing the science teacher's sophistication in science may soon reach the point of diminishing returns. It is past time that we should begin to consider the far more complicated phenomenon, *the learner*. We know all too little about learning as it relates to achievement in science. Much of what is done in science classes today is based upon theories of learning that have long since been demonstrated to be untenable. For these reasons it is proposed that the Association during 1961-62 focus attention on the learner in five major areas:

1. We should be more concerned about the learner in our curriculum planning. In recent curriculum efforts major attention has been given to science and for good reasons. But no curriculum becomes effective that is out of line with sound learning theory.
2. Evaluation programs, schemes, and devices should be examined in light of modern learning theory. Often the devices used contradict what is known about learning and the role of evaluation in the learning process.
3. Staffing problems in schools are rather exclusively settled in terms of what is to be taught rather than for whom the teaching is to be done.
4. Programming in science is usually decided by defining the content of courses and arranging them in a sequential order based upon content development. It may well be that the psychological factors involved in developmental learning would be better served if sequences in science were to a larger extent based upon the process goals of science teaching rather than the content goals exclusively.
5. Facilities too often are planned with more regard for what is to be taught rather than for how it is to be taught.

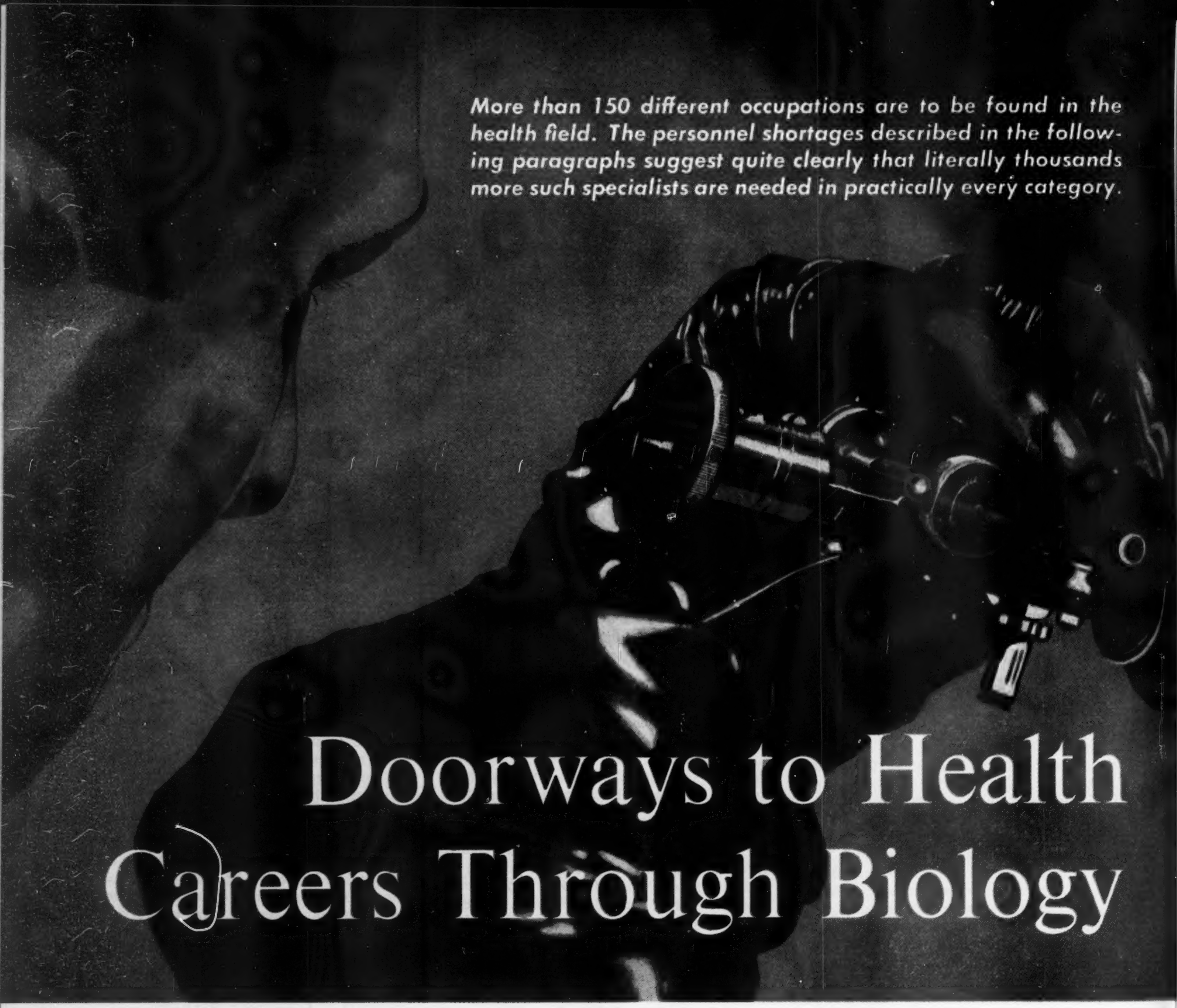
The 1962 Convention of NSTA has been planned to provide members an opportunity to focus attention on *the learner* in the five areas outlined. We are hopeful that the deliberations of members will lead to convention resolutions. These in turn will serve as suggested guidelines for the future work of the official NSTA committees and boards, thus leading to an ever more effective professional Association.

J. Darrell Barnard
President, NSTA (1961-62)

International Education Opportunities, 1962-63

During the 1962-63 school year, approximately 400 grants are available for teaching abroad in 40 countries. Elementary, secondary, and junior college teachers of all subjects may apply through the teacher exchange program administered by the U. S. Office of Education in cooperation with the Department of State. Applications will be accepted from August 1 through *October 15, 1961*. For information write Teacher Exchange Section, Office of Education, Department of Health, Education, and Welfare, Washington 25, D. C.

More than 150 different occupations are to be found in the health field. The personnel shortages described in the following paragraphs suggest quite clearly that literally thousands more such specialists are needed in practically every category.



Doorways to Health Careers Through Biology

By ISRAEL LIGHT and JULIAN A. WALLER

Public Health Service, U.S. Department of Health, Education, and Welfare, Washington, D.C.

At eighteen, Joe had been in and out of a training school for delinquents twice. His speech defect had marked him. His school had never included the services of a *speech therapist* or *psychologist*.

In a city where Mr. Jones lived, the health department tried to set up a voluntary plan with the local medical society whereby all women of child-bearing age could have a vaginal smear taken regularly as a preventive check for cancer of the uterus. The massive project never got started because of the bottleneck caused by the lack of trained *medical technologists* in the clinics and private pathology laboratories.

A housewife was "going crazy" trying to locate a *nurse* to help take care of her husband who had just come out of a serious operation and who would be bedridden and helpless for at least six weeks. There just were not any nurses to be had!

Eight-year-old Joanne was in the Children's Hospital, flat on her back with polio. Long and tedious sessions of exercise and massage could at least get her to the crippling-walk stage, if only more *physical therapists* with the proper training were available!

The branch plant of the chemical company was having a morale problem with its employees, because, among other things, the meals in the cafeteria were mighty bad. Why? The management had not been able to find a competent *dietitian* or *food service supervisor*. The families of the employees were also unhappy because of the choking fumes which came from the plant

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NOTE: Dr. Light is Information Officer in the Bureau of State Services, and Dr. Waller is a physician in the PHS Regional Office, Atlanta, Georgia.

chimneys. Clearly, an *air pollution engineer* was needed.

If science teachers have a suspicion that, somehow, they are implicated in these little vignettes—they are right! In self-defense, some might say: "Why come to us? That's what vocational and career counselors are for! I teach science!"

But, the problem is not so easily ignored. No one denies the key role played by vocational counselors in guiding students toward career plans and decisions. These people possess considerable information on career opportunities, their particular academic requirements, and employment possibilities, and are heavily involved in the assessment of aptitudes and skills. Students should have all this information about their career interests and about their own capabilities. At the same time, many educators feel that it is the subject-matter teacher who initially lights the fire or fans the flame of interest in many students, who then seek the career details from the vocational counselor in the school.

This is but one way of saying that, in the widespread call for more science in secondary schools, a major function of these courses has been overlooked. They not only prepare students for college work in these many fields; at least as importantly, they also motivate students to choose these careers. For many students the first and dominant image of what life as a scientist and engineer can be—is obtained in the classroom.

Health Career Shortages

Emphasis must be given to health careers for a number of reasons. *First,* medical science has reduced infant mortality and enhanced the health of adults to the point where most of us are living longer. Since 1900, life expectancy has jumped from somewhat over 40 years to about 70 years. The communicable and infectious diseases, such as diphtheria, whooping cough, small pox, typhoid, scarlet fever, and malaria have given way to the chronic, degenerative diseases, like cancer and heart ailments. These diseases often require extended treatment and a battery of newly-developed skills and talents under qualified personnel.

Second, research is developing new methods of diagnosis and therapy, if not cure, to a host of neurologic and metabolic disorders such as cerebral palsy, muscular dystrophy, cystic fibrosis, and multiple sclerosis as well as for the more conventional, better known ailments. Again, these developments have added "staff" to the physician in the form of new health-related specialties listed on page 10.

Third, a number of health and hospitalization plans bring many more people within the range of treatment more frequently. The individual is increasingly interested in *staying* well as compared with *getting* well. This means more physical checkups, more specialized examinations, and more therapy in more clinics and hospitals, requiring more staff to use more and ever newer tools of diagnosis and treatment.

Fourth, some 70 million more people will be added to our national population in the coming twenty years—a number almost equal to the entire country's population in 1900.

Fifth, the proportion of the young and the old in the total population is increasing at a faster rate than is the 25-60 age group. This results in increasing competition among the professions for personnel, and the new or the glamorous ones win—nuclear engineering, astronautics, medicine (the physician), and research are examples. At the same time excellent training and career opportunities remain in many of the less esoteric health professions so that both the average and brighter students can often find a satisfying lifework in helping people.

Why focus on biology? Because there still unfortunately exists a pattern of high school course offerings and graduation requirements in which biology may be the *only* science to which thousands of students get an exposure; the biology course provides the most comprehensive introduction to health-career possibilities; and the biology course is in the process of completely

The nurse and physician are important contributors to medical science research which includes the exercise and development of new methods of diagnosis and therapy for improving infant health.
NATIONAL INSTITUTES OF HEALTH

being overhauled by means of the exciting developments of the Biological Sciences Curriculum Study, University of Colorado, Boulder.

Health Careers Identified

Now, who are these people who work in the medical-health field? Some forty are presented, as a random selection, and are grouped in seven categories based on areas of *major* emphasis given in the following:

Basic Sciences

- Laboratory Technician
- Physiologist
- Statistician
- Medical Entomologist or Lymnologist
- Basic Science Researcher
- Bacteriologist or Mycologist
- Food and Drug Chemist
- Geneticist

Direct Patient Care

- Physician
- Dentist
- Registered or Practical Nurse
- Optician, Oculist, Optometrist
- Chiropodist
- Ambulance Driver
- Physical Therapist
- Occupational Therapist

Educational Interests

- Health Educator
- Public Health Service Program Representative
- Voluntary Health Agency Worker
- Medical Science Writer
- Speech Therapist
- Teacher of Deaf, Blind, Retarded
- Hygiene Teacher

Psycho-Social Interests

- Public Health Nurse
- Psychologist
- Medical Social Worker
- Psychiatric Social Worker
- Public Health Anthropologist or Sociologist
- Vocational Rehabilitation Counselor

Mechanical Interests

- Brace or Limb Maker
- Medical Artist or Photographer

Administrative Interests

- Hospital Administrator
- Voluntary Health Agency Worker

Other

- Mortician
- Sanitarian
- Medical Secretary
- Drug Salesman
- Veterinarian
- Nutritionist
- Sanitary Engineer

In the comprehensive scientific community of the National Institutes of Health, this woman physician finds many opportunities for professional development available in research and medical health.

The National Health Council has issued an education and training calendar of 76 health careers. This appears elsewhere in this presentation as a useful shorthand reference.

Course Content Relevance

Rather than spell out in compilation form the various duties and skills required of a long series of health specialists, the following paragraphs identify the subject-matter elements in a typical biology course and indicate one or more careers affiliated with the medical-biological-life sciences for which such facts and knowledge are particularly pertinent. Bluntly stated, the authors realize that what students are learning and reading about in a book constitutes at worst a set of facts to be recalled at periodic examination time, or perhaps some interesting facts to be forgotten conveniently the following year. The student can learn that these facts are used *"for real"* by people who spend a lifetime healing the sick and keeping the rest of us in good health.

Many of the professions listed above, for instance, can be illustrated adequately by referring to a number of topics which are usually taken up in all biology classes. These topics include: cell structure and function, plant groupings and discussion of common plants, classification of the animal kingdom, relationships between man and insects,

physical and mental health, the human body, basic hygiene, reproduction and heredity, life of the past and present, and the wise use of natural resources.

Every one of these subject areas is parent to a number of practical health-oriented specialties. A variety of health professions cut across several subjects in their preparation and application.

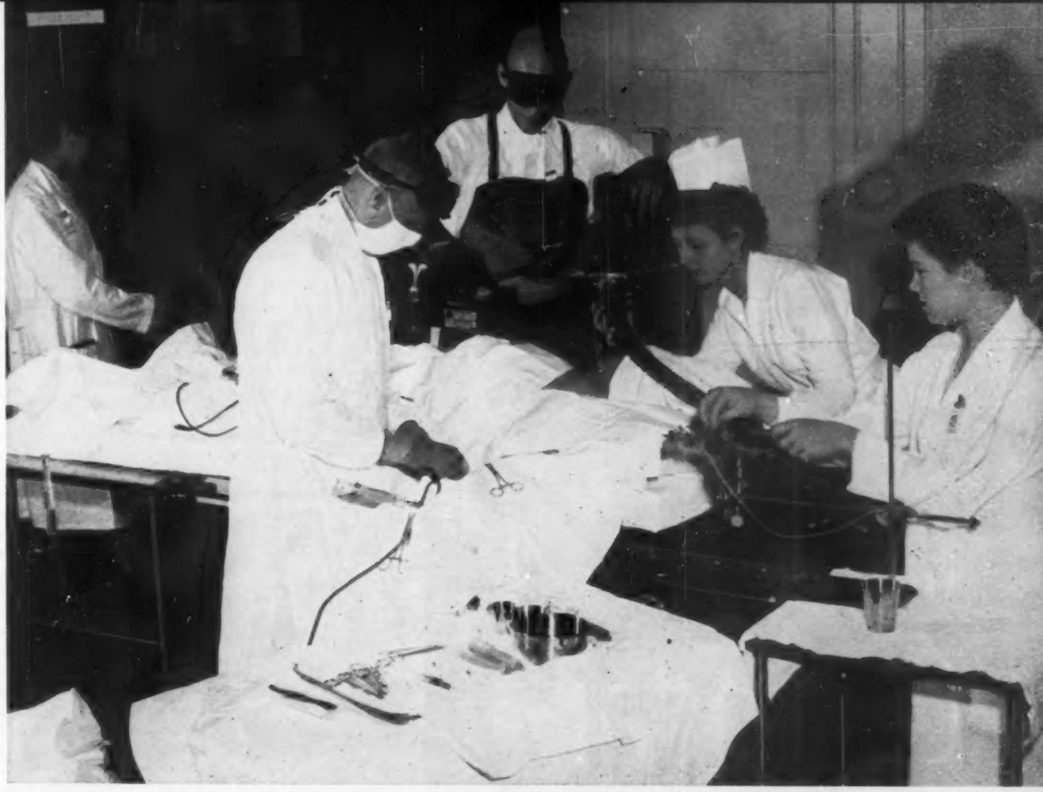
Is *cell structure and function* the subject of the day? The list of specialists drawing upon this subject would include the physiologist who studies why the heart muscle fatigues, or changes in cell metabolism causing arthritis, diabetes, muscular distrophy, cancers, etc. The bacteriologist, virologist, and mycologist are interested in minute cellular differences which might make one organism benign while a closely related cousin is malignant and a killer. By knowing such differences, proper therapy can be developed. The medical technologist, on the other hand, wants to know how to distinguish different types of blood cells and how to identify a single cancer cell in a smear containing several thousand normal cells, while the biochemist and electron microscopist may use cell level studies to learn about basic life processes.

Perhaps you are discussing *plant groupings and common plants*. The future pharmacologist would like to know that lily of the valley contains a heart stimulant, or that pain killing drugs come from the oriental poppy. But the accident-prevention specialist would also like to know this because the decorative castor plant which produces castor oil can kill a child who ingests the bean. Many other garden plants have similar toxic effects.

The future biochemist might be interested here in the plant oils which make poison ivy a problem, or in the nutritional value of different plants and the possible relation of certain plant oils to the prevention of heart disease (which, of course, would interest the nutritionist). The immunologist wants to know why certain pollens cause allergies and related effects.

Many specialists are interested in the bacterial and mycotic groups, from the sanitarian who must know about food contamination and the process of sewage degradation to the nurses, laboratory technicians, and others, who must culture and sterilize areas with pathogenic organisms.

An adequate knowledge of the *classification of the animal kingdom* is vital to a number of professions from the veterinarian, through the sanitarian or epidemiologist who may have to identify which animal is most likely to carry rabies, psittacosis, or a number of parasitic diseases, to the lymnologist who determines that a certain snail transmits parasitic worms to man while another snail which looks exactly like it is harmless in this respect.



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Here a nurse assists during cardiac catheterization and is an important part of the team which is conducting research on heart function while doing the utmost for the patient. In addition to medical scientists, other members of the research team include the electrocardiographic and laboratory technicians.

When the class studies *insects,* a number of specialists will indicate their relevance to the subject. The medical entomologist wants to distinguish the various mosquitoes that carry yellow fever and malaria, the flies that carry sleeping sickness and a host of exotic diseases, the fleas which still carry bubonic plague in California, or the ticks which carry Rocky Mountain spotted fever or Rickettsial Pox. Future sanitarians, biochemists, and nutritionists might want to be familiar with insecticides such as DDT and Dieldrin to control disease vectors and crop destroyers. And why do certain insects become resistant to insecticides? The geneticists are working on this question and at the same time are finding out how to control insects by sterilizing the male with X ray so that the female who mates only once in a lifetime will produce sterile eggs.

We now enter the "traditional" subject area of health professions—*the human body, physical and mental health, and basic hygiene*. The three groups of workers concerned with direct patient care, educational interests, and psycho-social interests find their operational sustenance here. In addition to those who are directly related to the therapy of acute disease, we would like to emphasize three trends that are apparent in the lists of health related professions or fields.

First is the development of information specialists—the health educators, science writers, program representatives, and voluntary health agency workers—who are attempting to bring to the public an awareness of the *prevention and early treatment* of disease. Second is the burgeoning group of people interested in the late complications of disease, with the "back room" children of yesteryear. This list includes the physical and (occupational and speech) therapists, teachers of exceptional children, vocational rehabilitation counselors, medical social workers, public health nurses, and brace makers.

Third is the trend toward medical administration and the coordination of existing resources. For this reason we have included the medical sociologist and anthropologist. These latter two

This calendar gives you a quick check on how many years of education, after high school, you should count on for the representative health occupations listed here. The lines and symbols show what is customary — some people take only minimum required training; many take more.

HEALTH CAREERS

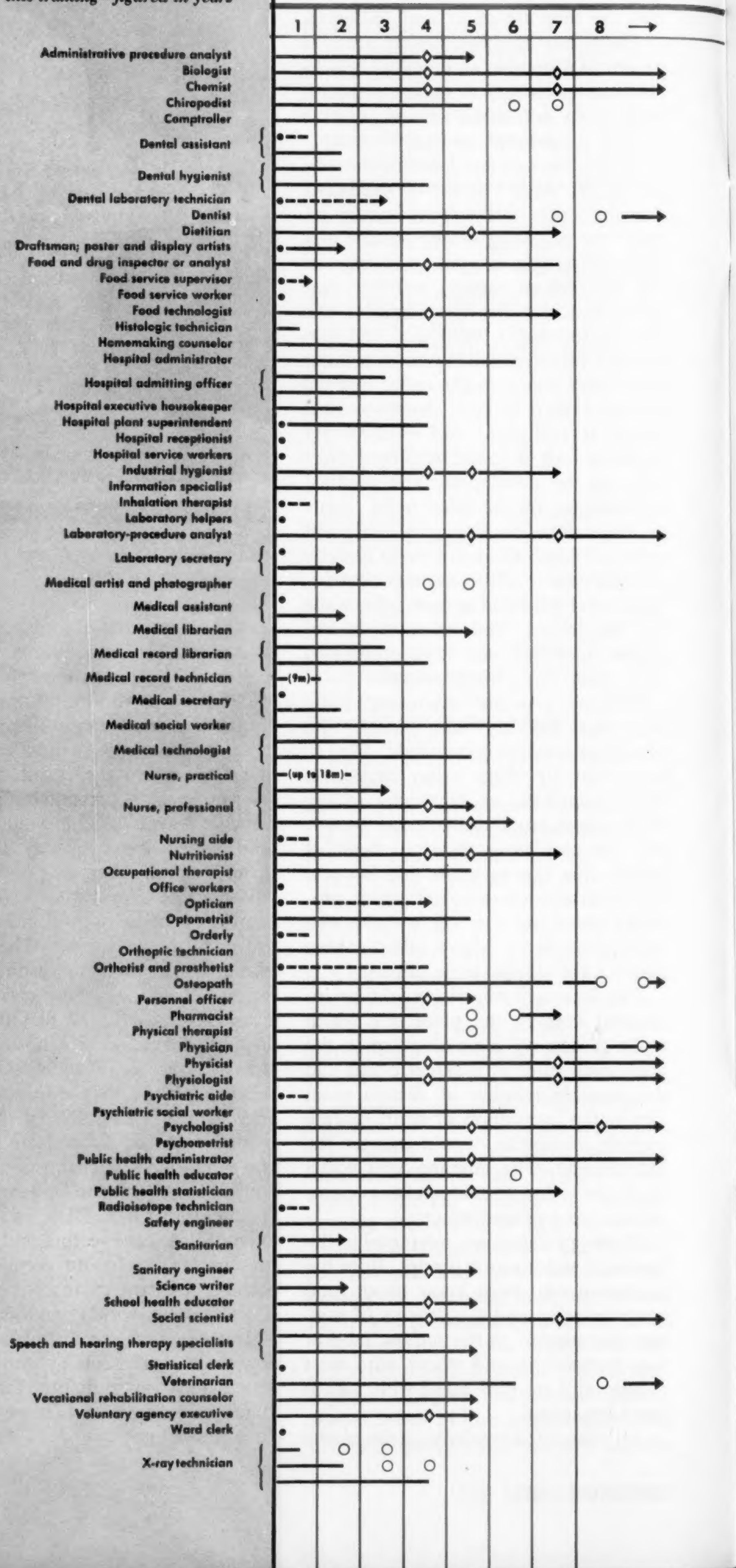
Calendar

- This kind of work requires no special training beyond what you can usually get in high school.
- After starting, you serve an apprenticeship or get similar organized on-the-job training.
- Lines and symbols used with them indicate full years. To start requires special training either in college, in a hospital or special school, or in a professional school after 1-4 years of college.
- Special training is required, but you have a choice, each type of training taking a different number of years.
- First symbol means you can get beginner's job after college, but will usually need more study, as well as experience, for advancement. Graduate training ordinarily goes to or beyond master's or doctor's degree.
- Your planning should look beyond minimum requirements; continuing study, after entering professional practice, is important to further advancement.
- Though the line shows minimum to qualify, more pre-professional years in college often lengthen the total training time.
- (9m) Length of training is shown in months.

The calendar pictures training information in condensed timetable form. To get a more detailed picture . . . read the HEALTH CAREERS GUIDEBOOK Briefings . . . consult your school advisers for information and personal guidance on training and the local outlook for the career you want.

Reproduced by permission of the National Health Council, New York City

After you are graduated from high school these health careers take this training—figured in years

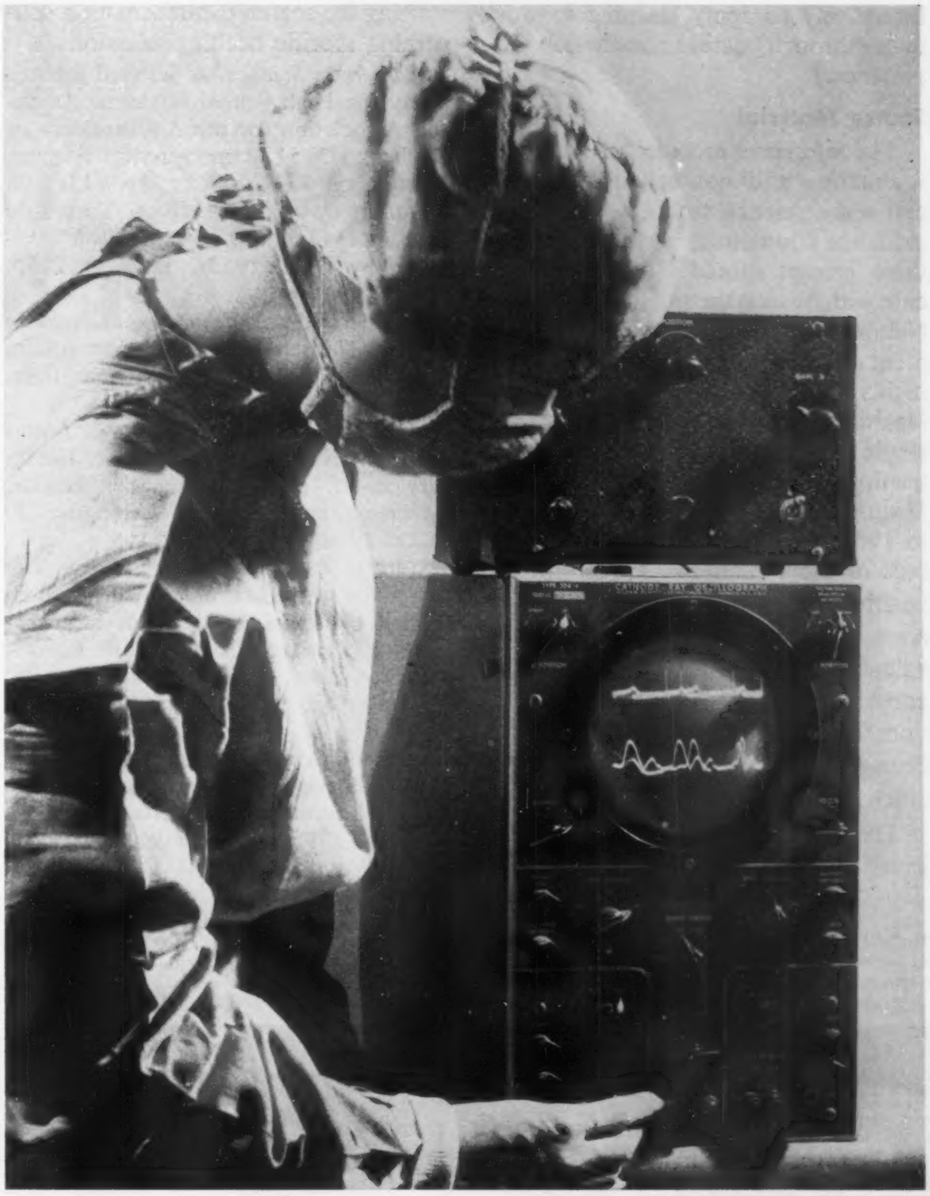


professions are currently studying *past and present tribes and ethnic groups* to learn more about patterns of medical care and how to motivate groups to seek adequate health supervision.

Reproduction and heredity are always interesting subjects to the student. For the mathematically oriented individual, a career in genetics presents such challenges as the hereditary pattern of rare diseases; namely, sickle cell anemia and amyotrophic lateral sclerosis, or such common conditions as the heart diseases and cancers. The basic science researcher can devote his time to the effects of radiation on food and insects, both of which, by the way, are of interest to the sanitarian.

Radiation, of course, brings up the health problems related to the pollution of air, water, and food supplies which have their own army of superspecialists. This group again deserves mention in any discussion of the *wise use of natural resources*. We have a two-fold job, namely, to preserve our valuable food, air, and water supplies which are already gravely threatened, and to teach the public to conserve its human resources through proper care of mind and body, through accident prevention, adequate immunizations, etc.

This necessarily brief scanning of biology-course topics relevant to health careers is presented to alert the teacher to the broad spectrum of disciplines in the medical-biological-life sciences in which interested and talented young people can find fascinating, lifelong professional careers. (Space limitations do not permit examination of the tremendous opportunities in the so-called "laboratory sciences" which are directly related to the laboratory exercises accompanying classroom instruction in biology, as well as other courses.)



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Complicated instrumentation is becoming more essential to medical research and to medical procedure. This work calls for the development of many specialized skills and talents in technical fields.

From Textbook to Job

Exposure to the realism, understanding, and utility of biology course subject-matter invites follow-through. Health careers abound in any community: hospitals, clinics, pathology laboratories, dental laboratories, the offices of physicians and dentists, company plants, public schools and colleges, restaurants, nursing homes, public health departments, local headquarters of voluntary health organizations, and research laboratories. It is "old hat" for the classroom teacher to invite "outsiders" to visit the classroom for purposes of vocational enlightenment. The teacher should continue this practice of relating the instructional program to the workaday world. (By the way, how many biology teachers call in the coroner or the police department's laboratory chief, when it is desired to show the versatility of the microscope?)

The *added* recommendation here is that the teacher should supplement the classroom and textbook presentation by inviting those people who can add to the student's fund of basic knowledge. The fascination of the subject can be as effective, if not more so, than the livelihood aspects. Thus, a talk by a pathologist or bacteriologist who explains and describes the latest findings of the contents and workings of Golgi, or the manner in which viruses are believed to reproduce, or the way typhoid was tracked to its source in a recent outbreak—such presentations may do more to fire students' enthusiasm for a subject or discipline than a catalog of where people do what, for how much pay, and how much training is required.

These outside contacts possess four particular advantages: (a) the teacher can be stimulated; (b) the pattern of classroom instruction is varied; (c) students may be led voluntarily to undertake special studies or experiments; and (d) some students may look for summer and/or part-time employment in these fields. (Obviously, there is no

better way to apply learning to work than through actual on-the-job experience.)

Source Material

The references included here are representative and not exhaustive. They can serve science teachers, vocational guidance counselors, and students. All three groups should either communicate with or seek the publications of the National Health Council, a nongovernmental organization which maintains a highly competent, active, and useful Health Careers staff and program. The single most useful and outstanding publication of the NHC in this field is *Health Careers Guidebook,* published in 1955. This volume includes the details of more than 150 careers in the health field. A supplement, *New Careers in the Health Sciences,* is equally valuable, and will be available in the early fall. A copy of these two publications should be in every high school library and vocational counselor's office, large or small.

The following bibliographies, selected randomly, may be helpful in starting the search for information concerning specific health professions:

Careers in Science. A Selected Bibliography for High School Students. American Association for the Advancement of Science, 1515 Massachusetts Avenue, Washington, D. C. 1961. 22p. (15¢)

Career Opportunities. New York Life Insurance Company, 51 Madison Avenue, New York 10, N. Y. 1958. 288p. (Free)

What's in Your Future—A Career in Health? Herbert Yahraes. Public Affairs Pamphlet No. 281. 22 East 38th Street, New York 16, N. Y. 1959. (25¢)

A List of Public Health Service Materials on Health Careers. Public Health Service, U. S. Department of Health, Education, and Welfare. Washington 25, D. C., 1960. 4p. (Free)

Career Opportunities in Biology: The Challenge of the Life Sciences. Russell B. Stevens. National Academy of Sciences-National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D. C. Reprint, 1957. 64p. ($1)

Toward a Healthier World: Your Career in Sanitary Engineering. Public Health Service, U. S. Department of Health, Education, and Welfare. Publication No. 579. Superintendent of Documents, Washington 25, D. C. 16p. (25¢)

Books on Careers in Nursing. Committee on Careers in Nursing. National League for Nursing, 10 Columbus Circle, New York 19, N. Y. 10p. (Free)

The following organizations will gladly furnish career information:

American Dietetic Association, 620 North Michigan Avenue, Chicago 11, Illinois.

American Society for Pharmacology and Experimental Therapeutics, 9650 Wisconsin Avenue, N.W., Washington 14, D. C.

American Association of Colleges of Pharmacy, College of Pharmacy, University of Illinois, 833 South Wood Street, Chicago 12, Illinois.

American Dental Association, 222 East Superior Street, Chicago 11, Illinois.

New York Life Insurance Company, 51 Madison Avenue, New York 10, N. Y.

B'nai B'rith Vocational Service, 1640 Rhode Island Avenue, N.W., Washington 6, D. C.

American Society of X-Ray Technicians, 16 Fourteenth Street, Fon du Lac, Wisconsin.

American Occupational Therapy Association, 250 West 57th Street, New York 19, N. Y.

The young technician becomes a valuable employee in the research laboratories. The concentrated program in the laboratory often stimulates the technician to become a fully qualified professional scientist. On the left, a technician is adjusting apparatus used in a medical research facility. On the right, another technician is filling the cell of the ultra centrifuge with protein which is to be analyzed for purity or sedimentation rate at about 260,000 g.

NATIONAL INSTITUTES OF HEALTH

FEDERAL SUPPORT FOR EDUCATION

THE program for Federal Aid to Education has become a vital topic of interest to everyone concerned with national progress in this area, and particularly to those administering the program for the education of our youth. Currently, the Eighty-seventh Congress has before it three separate education bills which have been in debate and deserve your support and consideration.

1. HR 7300

This bill includes S 1021, the Administration Bill which is a proposal to provide funds for public elementary and secondary schools (and to extend Public Laws 815 and 874, the federally-impacted areas program) and HR 4970, the School Assistance Act of 1961, which is the companion measure to S 1021.

2. HR 7904

The NDEA Amendments of 1961 proposed by the Administration to extend the National Defense Education Act of 1958 beyond its four-year date of June 30, 1962, and to include additional provisions.

3. HR 7215

The Administration Bill is an amended version which replaced HR 5266 to provide funds for higher education. Two new provisions were added by the Special Subcommittees on Education (Green; D-Ore.).

With the convening of the 87th Congress, supporters of federal aid in the financing of education looked for legislation to provide assistance at two levels: the elementary-secondary and higher education. It came as somewhat of a surprise to find that special aid, provided ever since the 81st Congress to public elementary and secondary schools in "federally-impacted areas," was included in the Administration's proposal for assistance in school construction and teachers' salaries. This special aid had been provided by PL 815 (school construction) and PL 874 (operation and maintenance). The inclusion made good sense, however, since the laws were due to expire June 30, 1961 and since many of their supporters and beneficiaries could accept these provisions without a qualm at the very time they were decrying any proposal to make their type of special help available to all schools. One concession won by proponents of the two laws from the Senate and House Committees reporting the Administration bills (S 1021; HR 4970 now replaced by HR 7300) was that no cut should be made in "federally-impacted" funds until the proposed general aid law had been given a trial operation to see how it might affect present programs. There were rumblings that friends of the "federally-impacted" laws would seek to act upon them as a separate proposal but S 1021 was passed by the Senate May 25, 1961 with the renewal of these two laws still embodied in the bill as Title II. (It is reliably reported that the chances of passage of HR 7300 may very well hinge upon the success or failure of the supporters of this bill to keep PL 815 and PL 874 renewal provisions as Title II of the bill rather than to have them taken out and passed separately.)

The supporters of educational legislation before the Congress who had decided that this two-pronged attack on the problem of adequate financing of education made good sense were jolted to discover that the Administration proposed to broaden the attack to three prongs. They introduced legislation to include the extension and expansion of PL 85-864, popularly known as the National Defense Education Act of 1958, which was not due to expire until June 30, 1962. This decision had the unhappy outcome of catching some folks napping because it was assumed that action on this law could and would go over to a later

date, possibly even the Second Session of the 87th Congress. At one point in the proceedings, it was even suggested that all three proposals (higher education; elementary-secondary aid, including "federally-impacted" areas, and NDEA) might be wrapped up in one big legislative package. Those who hoped to see some constructive legislation emerge from this Congress were quick to point out that such an omnibus bill would, among other disadvantages, offer far too many loopholes through which support for the measure could be drawn off, and with results that would be disastrous. Therefore the three major proposals are being considered separately, but their ultimate fates will be closely interwoven, especially in the House. A great hue and cry has been raised both for and against making part of the proposed aid available to nonpublic schools, and so widespread has the uproar become that it has had to be reckoned as one of the factors having a direct bearing upon the passage of any legislation in this area. *Hence it is surmised* that a decision was made to act upon the renewal of NDEA at this time since it was believed that some of its provisions could be broadened to cover private schools more liberally, and thus forestall attempts to amend the other proposals with the possible result of defeat for the legislation. For example, the extension of the time which loans made to private schools under Title III of NDEA could run, and a more realistic calculation of the interest rate on such loans, might have a salutary effect in satisfying the protagonists for more equitable treatment of nonpublic schools.

Title III, NDEA

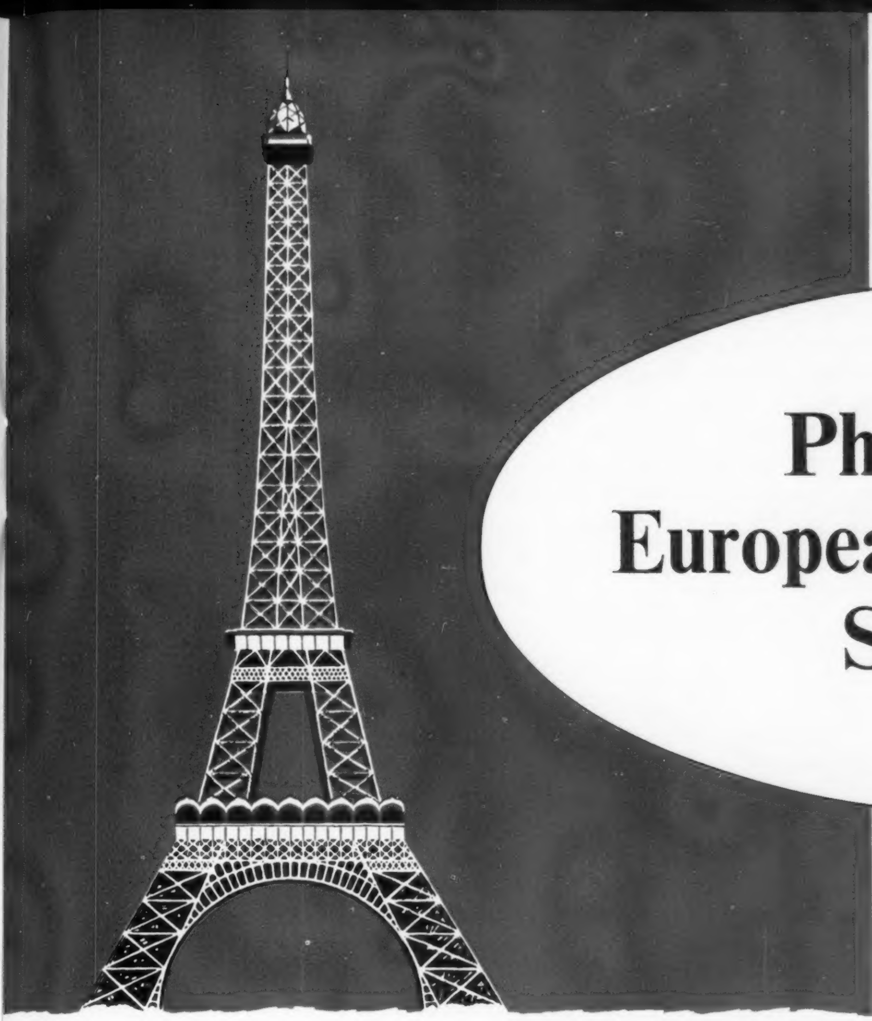
Without in any way implying that the interests of science teachers are coterminous with the limits of their subject matter, economy of space demands that this discussion be brief. Confining the scope of this report then to Title III of NDEA, some illuminating statements can be entered on the record. The United States Commissioner of Education, Sterling M. McMurrin, reported to the United States Senate on May 12, 1961, that during the first twenty-one months of the Act, $130 million of federal funds had been expended for new instructional equipment under Title III in approximately 57,000 school district projects. Of these expenditures, 76 per cent were in the field of science, 16 per cent in modern foreign languages, and 8 per cent in mathematics. More than 5000 classrooms and laboratories were remodeled to accommodate the new equipment. State supervisory staffs in these three fields rose from 33 in 1958 to approximately 203 at the moment of writing; 48 states now have professional personnel assigned in supervisory work in science; 47 in mathematics; 43 in foreign languages. However, 30 states have no *full-time* supervisors in science; 31 have no *full-time* mathematics supervisors; and not one state has a *full-time* supervisor in the modern foreign language field. In the matter of loans to private schools for the purposes of Title III, 161 applications have been approved for a total of $1,980,430. (The Commissioner or members of his staff pointed out that the present method of calculating interest rates *monthly* on such loans resulted in considerable confusion and resulted in a rate ranging from 3 per cent to 5 per cent. New proposals would stabilize this rate at about 3 per cent.) The panel of consultants consisting of 20 prominent leaders in industry and education which has been advising the Commissioner as to recommended changes in the law believes that the programs related to science, mathematics, and modern foreign languages should "be continued at present levels of authorization." The panel further recommends that Title III be expanded to include English and school library services and resources. The Council of Chief State School Officers whose duty it is to administer the "state plan" governing the disbursal of funds within each state believes the expansion should include not only English, but also "history, geography, economics, and government." The Council was rather sharply divided in the matter of the inclusion of "physical fitness" in this Title. The Council has made a comprehensive review of constitutional or statutory provisions governing those grants of public aid to nonpublic schools in all of the 50 states as a basis for discussion of broadening the provisions of Title III.

Despite the 1962 termination date for NDEA, efforts are being made to call the attention of Senators and Congressmen to the fact that, in the interest of orderly programming, school administrators must be given as much time as possible to plan definitely—either upon the renewal of the Act or upon its termination.

As this issue goes to press, all three major proposals of the Administration in the field of education have been refused clearance by the Rules Committee of the House of Representatives by a vote of 8 to 7.

Administration leaders in Congress currently abandoned efforts to pass the President's proposal for a three-year ($2.5 billion) federal aid to education measure. Plans were made for a one-year extension of the special aid provisions ("federally-impacted" areas) under PL 815 and PL 874.

Science teachers and educators are therefore urged to utilize the time from now until January 1962 when Congress reconvenes to advise their Congressmen of their views. The importance of federal support for education in all areas is a matter which must be decided by those of us who have to face this problem in our daily teaching activities.



Physics for European Secondary Schools

By FRED W. FOX

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The editors have received a number of letters from readers expressing the value and interest to science teachers of the material contained in an earlier published report.[1] One of the writers, Mr. Fox, volunteered to present a brief summary of the full report for TST. Permission has been received from the publishers for reporting this summary.

HIGH school science and mathematics teachers have welcomed the recent concern about science teaching in this country. Regardless of the wellsprings of interest, it has been gratifying to see enrollments increase, to find money available for better classrooms and improved equipment, and to watch the development of promising innovations in science and mathematics curricula. Two themes, among others, have continued to thread through discussion of science and mathematics education in the United States: the problem of the preparation of adequate numbers of scientists and engineers to keep our country strong in their fields, and the desire not to be excelled in these areas of education by Russia and Western European countries.

It is relatively easy for science teachers to accept the goal of starting more of our secondary school youth on paths to science and engineering specialization. Not only is it a challenging and worthwhile aim, but it appears achievable essentially through updated, more academic, and "rigorous" high school courses with generally decreased emphasis on technology. And for many classroom teachers, problems are simplified since this kind of science education seems quite proper for all students. Furthermore, there is the common impression among American circles that European secondary schools are quite successful with their present emphasis on the highly academic approach to science education. They are to be emulated for their program, and a close examination of their efforts would be profitable.

Not everyone agrees, however, that the primary objective of high school science programs is to provide initial preparation for future scientists and engineers. But at least one important recent report would lead us to believe that European secondary science education needs extensive modification at this time. The purpose of this article is to summarize a significant statement on physics teaching in European schools. Through this brief review it is hoped teachers of this country will see the problems our European neighbors face and the directions a group of eminent physicists recommend that science education should take in the future.

Physicists from twenty-nine nations participated in a conference under the auspices of the International Union of Pure and Applied Physics. Meeting in UNESCO House in Paris in late July and early August of 1960, these scientists heard and discussed a report prepared for the Office for Scientific and Technical Personnel of the Organiza-

[1] J. W. Buchta. "Physics Education." (Introduction to the report); Norman Clarke, *et al.* "The Teaching of Physics in Schools." *Physics Today*, 14:28-38. January 1961.

tion for European Economic Cooperation. The report dealt exclusively with the teaching of secondary school physics, but the thinking of these men warrants the attention of all science teachers. The original report[2] should be read by every science teacher and educator in our country.

The major purpose of secondary school science teaching is not the preliminary preparation of scientists and engineers, these physicists stated. Rather, in what becomes virtually the keynote of their report, the *cultural value* of science should be the determiner of science offerings. This basic view is reflected in the quotations from the report which follow:

> Our own discussions have been based on our strong belief that physics, the most exact and fundamental of the sciences, is a vital part of modern culture and, as such, a necessary element in the education of all children. . . . *The cultural value of science*—which is all too often inadequately appreciated—*should be the aspect which determines the extent and the nature of the science courses in schools*. . . . Science provides a new process of thought, and new criteria of credibility and of acceptability of evidence. . . . In the present context, it cannot be too strongly emphasized that science is one of the humanities.[3]

To many science teachers it may come as something of a surprise to hear physicists say that the needs of nations may not necessarily be best served by preparing children to enter universities for careers in science and engineering. The conference in Paris was not concerned with one nation "catching up" with another or with "national defense" policy, but the education of children in all nations. Physics, these scientists say, should have a place in every child's education for two reasons: (1) The highly imaginative intellectual and consistently integrated picture drawn by physicists of man's world is a remarkable tribute to the power of the human mind, and (2) the model of nature that physics provides must necessarily be a part of serious thought given to most of the perennial problems that man attempts to solve as a social being. With such views in mind, the physics teacher is able to prepare children for the adult world in which they live—an essential purpose of education—and, at the same time, he is able to meet another aim for some students of secondary school physics, the initial preparation of specialists in the science fields.

Two essential criticisms of secondary school physics teaching today are first, that it is dull and uninteresting, failing to capitalize on the common interests youth have in the world about them; and secondly, that children seldom get a real picture of what science is all about and of the way in which scientists think. "An appreciation of the intellectual power and significance of science and some understanding of the scientist's picture of the world are as important a part of the education of all children as are history and literature." To eliminate persistent problems in physics education and to meet recommended goals, first consideration must be given to what is taught and how.

Basic Course Proposal

The course the physicists have in mind should be for general education purposes, should be for children of about twelve to sixteen, and should involve a very high level of teaching. Not recommending a curriculum designed mainly to prepare specialists, the report states, "the kind of basic course we have in mind should, in fact, improve the quality of specialists or at least make easier their subsequent assimilation of the more difficult abstract and mathematical aspects of physics."

The committee repeatedly refers to the need for achieving the broad aims outlined above by teaching physics to all secondary school children. However, it recognizes that it must come to grips with an actual proposal of curriculum and methodology, and that realistically it must start with only a portion of the student body. Thus, the committee sketches a physics program for the 15-20 per cent of the most able students in the majority of the schools.

A first prerequisite for the proposed physics course is the teacher. His quality of mind and his approach to his subject are crucial elements. In order to pass to his students the unity of the physical sciences, he must have a concept of such unity himself. He must have a disposition to work closely with teachers of chemistry and mathematics. In his approach to teaching, the teacher must give careful consideration to the many methods available to him. For instance, using the "discovery" method to the exclusion of all others may be ill-advised and educationally unsound. In general, children need considerable guidance in their learning activities. A classroom approach relying heavily on experimentation may seem to be essentially in the spirit of science, but the teacher must not let his students miss the vital relationship between theory and experiment. On occasion, the experience should precede discussion of theory, but at other times, understanding of theory is a necessary prelude to effective experimentation.

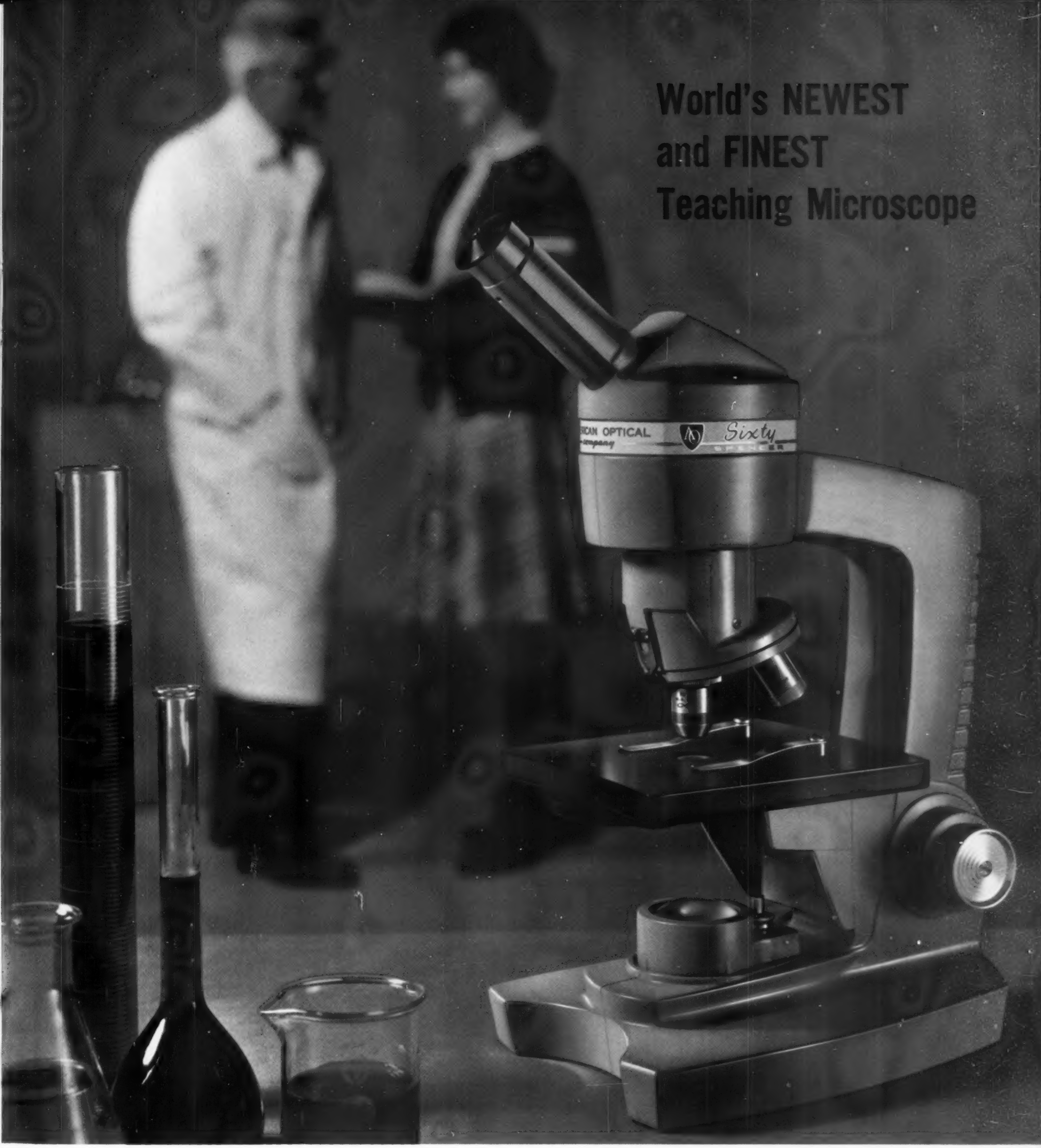
The content of a physics course for the most able students is determined by the conception that "physics should be presented as a unified whole with stress on the universality of physical laws," and it should start with modern concepts of the field. Expecting that the course will be taught three or four periods a week over a period of four years, it should be offered as a separate subject starting at ages twelve or fourteen at all schools.

When planning the content of a physics course, two considerations must be kept in mind: first, that most children today have a familiarity with such concepts as atoms, molecules, and electrons, and this may well serve as the starting point for the syllabus; and second, physics should be presented in modern terms wherever possible. Recognizing these points the committee suggests not starting with the traditional discussion of mechanics but with the particle nature of matter. The broad outline of the proposed course is recommended as follows:

1. The particle nature of matter. General ideas of the differences between atoms, molecules, and electrons.
2. Beginning of an understanding of the basic concepts of laws of mechanics, with an emphasis on the physical significance of the concepts. (The children should grasp firmly "the physical significance of energy, work, force, velocity, acceleration, mass, and momentum; and the conservation of energy and momentum. They should know something of the measurement of time.")
3. The simple properties of gases and vapors; ideas of temperature and pressure as phenomena of particles in motion; states of matter and special changes of state in terms of

[2] *Loc. cit.*

[3] *Ibid.*, p. 30. (Italics added.)


World's NEWEST
and FINEST
Teaching Microscope
Sixty

aggregations of atoms and molecules; and chemical bonds.

4. Measurement of temperature and the transfer of heat; the laws of thermodynamics; and the energy supply available in nature.
5. The structure of atoms; electrons as carriers of electricity; electrostatics; thermionics; electromagnetism; and magnetism.
6. Mechanical, acoustic, and electromagnetic vibrations.
7. Light as electromagnetic radiation; geometrical optics; diffraction; interference; emission and absorption of light; simple ideas of quantum theory; and emission of X rays.
8. Radioactivity; structure of the nucleus; nuclear reactions; equivalence of mass and energy; and elementary introduction to relativity.

Laboratory work in the proposed course is of great importance. However, it is recommended that a balance be struck among laboratory work, teacher or student demonstration, and the presentation of theory. Early in the program, for the twelve- and thirteen-year-old children, there should be heavy reliance on teacher demonstrations.

Obviously there will need to be a certain amount of mathematics education for the physics student. For the able student taking the special physics course, algebra should begin at age thirteen or fourteen, quadratics and logarithms at fifteen. The idea of limit and familiarity with first and second derivatives of a function should follow numerical methods and methods of approximation. Elementary statistics are important from a physicist's point of view. Cooperation between the physics and mathematics teacher would enhance the total program.

The committee of physicists offers brief recommendations for two courses advanced beyond the one described above: one for the student going on to the university with special interests in the humanities, and one for the student intending to become a science specialist in one of the disciplines.

Briefly, the student interested in the humanities should have a course which shows children "the way in which the emergence of modern science has influenced men's thinking about philosophical problems," including "examples of difficulties of a philosophical nature which the scientist himself has had to face." An appreciation of the unity of science and its utility should be developed, but a distinction between science and technology should be carefully drawn.

The student going on to the university as a specialist in science should begin to see and think about his subject as a whole. While the teacher would be offered considerable flexibility in planning his course, his essential aims should be to aid the student in acquiring more extensive and more detailed knowledge of his subject. The student also should develop those habits, skills, and attitudes which will be of value to him in the university and subsequently as a practicing scientist.

The success of the courses reviewed above will depend on the quality of the teachers. For the most part, teachers of these courses will have to be physics specialists who enjoy teaching young people. Not only will undergraduate training have to be adequate in depth and quality, but teachers should also maintain a professional contact with their colleagues in the universities and industry. In order for teachers to maintain their high abilities, the committee suggests establishing an international institute to provide secondary science teachers with refresher and advanced courses of several months' duration.

Physics teaching in many of the world's secondary schools is undergoing far-reaching readjustment. To punctuate the urgency of current needs the committee of international physicists states in its conclusion:

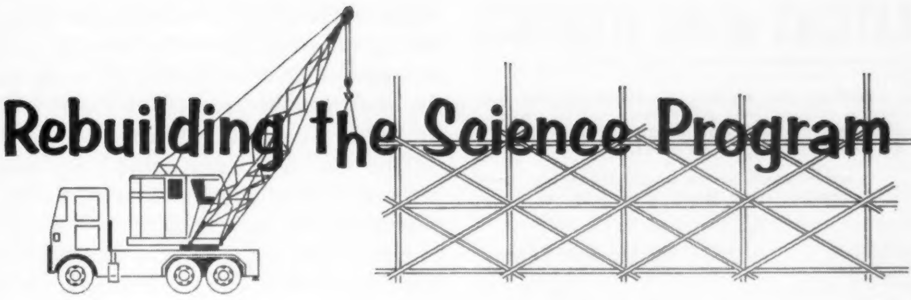
> Nothing less than a radical change will suffice if we are to succeed in giving to children, as part of a liberal education, a worthwhile introduction to full understanding of the place of science in their lives and the method by which science is carried on and advanced. . . . We need to educate children to appreciate that science is, in fact, one of the humanities and a major part of culture. To a nonspecialist as much as to the specialist, science is worthy of study for its own sake irrespective of the value of its applications.

The message, which the international assemblage of physicists seems to be offering us, is that science should be taught as a discipline which is culturally alive and vitally significant in the twentieth century. The reader of their report agrees that they entertain the fears which Toynbee expressed as he summarized formal education in the perspective of history:

> One consequence is to make education become a burden on the mind. . . . There [is] a temptation to try to facilitate the acquisition of the growing heritage by simplifying its content at the cost of impoverishing it. For educational purposes the culture may be reduced to a conventional form in which it will tend to become impersonal, secular, and abstract; and in this process the living essence of the culture may slip out of the meshes of the educational net.[4]

The question for us raised by the report of these physicists is this: Are the goals and courses recommended for European secondary schools acceptable for the physics students of American high schools? If not, what are worthy alternatives? Commendable efforts are being made in this country through extensive curriculum planning in physics, chemistry, biology, and mathematics. Do these proposals meet the broad and challenging standards set before our European neighbors?

[4] Arnold J. Toynbee in Edward D. Myers. *Education in the Perspective of History*. Harper and Brothers, New York 16, N.Y. 1960. p. 270.



Physics

Teaching Modern Atomic Structure

Use of The Electron Chart

By JACK W. EICHINGER, Jr.

Professor of Chemistry, The Florida State University, Tallahassee, Florida

A NEW chart has been developed to help chemistry students understand modern atomic structure. It simplifies the teaching of electron configurations, chemical bonding, and the systematic classification of the elements. This chart, which can either supplement or replace the periodic table, graphically displays the electron configurations of all the elements simultaneously. Complete information concerning shell and subshell structure, paired and unpaired electrons, available empty orbitals, and even such exceptional configurations as those of copper and palladium are provided. The student who understands the construction and use of this chart has a wealth of information at his disposal which does not have to be memorized. He learns to use the chart as a tool and engages in more reasoning processes and less of memorization.

This article is a condensed summary of an extensive report prepared by the following high school teachers with assistance from the author who submitted the summary for TST. Karl J. Aaberg, Mankato Senior High School, Mankato, Minnesota; Brother Bernard Berendsen, C.S.C., Notre Dame High School, Sherman Oaks, California; William H. Entrekin, Jr., Albany High School, Albany, Georgia; Philip Fromhartz, Central High School, Valley Stream, New York; Merle L. Gardiner, McHenry Community High School, McHenry, Illinois; Carrol C. Hall, Springfield High School, Springfield, Illinois; William M. Hunt, Seacrest High School, Delray Beach, Florida; Sister Mary Jane, O.P., SS Peter and Paul High School, Saginaw, Michigan; Kathryn P. McHugh, Tuley High School, Chicago, Illinois; Edward M. Miley, Staatsburg Union School, Staatsburg, New York; John E. Murphy, Pulaski High School, Milwaukee, Wisconsin; Ida Bell Phinney, Slocomb High School, Slocomb, Alabama; Julia Rand, John Adams High School, Cleveland, Ohio; Douglas Stewart, Atascadero High School, Atascadero, California; and J. A. Whitley, Hillfield College, Hamilton, Ontario, Canada.

Labeled "Electron Configurations of the Elements" (See Figure 1), the chart was first published in 1957[1] and is called the "Electron Chart" for short. It has been included in some recent textbooks[2, 3, 4] and a booklet describing the construction and use of the chart has been prepared.[5]

What Information Do We Need?

The essentials for the formation of chemical bonds are usually unpaired electrons which can be made to form pairs, and orbitals in which the resulting electron pairs can "live." We need information about the relative energy levels of the orbitals possessed by the different elements, as well as a knowledge of the occupancy of these orbitals by electrons. With this information, we can tell whether chemical bonds are likely to form and what valences and oxidation numbers to expect. If we also have a general idea of electronegativity values, we can predict something about the ionic or covalent character of the resulting bonds.

Electronic Energy Levels

All atoms, from the smallest to the largest, possess a great many different energy levels (orbitals) which may be occupied by electrons. There is never a housing shortage because there are never, even in the largest atoms, enough electrons to fill all of the "rooms." There is a scramble for the more desirable locations (the orbitals closest to the nucleus). The electrostatic attraction between the positive nucleus and the negative electrons will tend to bring the electrons as close as possible to the nucleus. The only way we can force one of these electrons to move to a larger orbital is by forcing the atom to accept some extra energy. The atom will only accept energy in packages (quanta) of precisely the right amount to "promote" the electron to the next higher energy level.

Each shell of energy levels beyond the first can be divided into subshells. The orbitals within a given subshell are exactly equivalent to each other in energy and different from those of any other subshell. The precise energy levels of one kind of atom belong exclusively to that element and are somewhat different from the corresponding energy levels of another element. The energy of an electron occupying the 1*s* orbital of a hydrogen atom is not quite the same as the energy of another electron which occupies the 1*s* orbital in an oxygen atom. We also find that the shells overlap in energy values. For example, the highest energy subshells of the third main shell (called 3*d*) lie at a somewhat higher level than the lowest energy subshell of the fourth main shell (called 4*s*).

To present this sort of information in a convenient, compact form so it may be applied to the problems of

[1] J. W. Eichinger, Jr. *Journal of Chemical Education*, 34:70. 1957.

[2] J. V. Quagliano. *Chemistry*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. (In process.)

[3] K. B. Hoffman. *Chemistry for Nurses*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. (In process.)

[4] G. M. Bradbury, *et al. Chemistry and You*. Lyons and Carnahan, Chicago, Illinois. (Revision in process.)

[5] J. W. Eichinger, Jr. *Surveying the Elements with the Electron Chart*. Charts Publishing Company, Tallahassee, Florida. 1959.

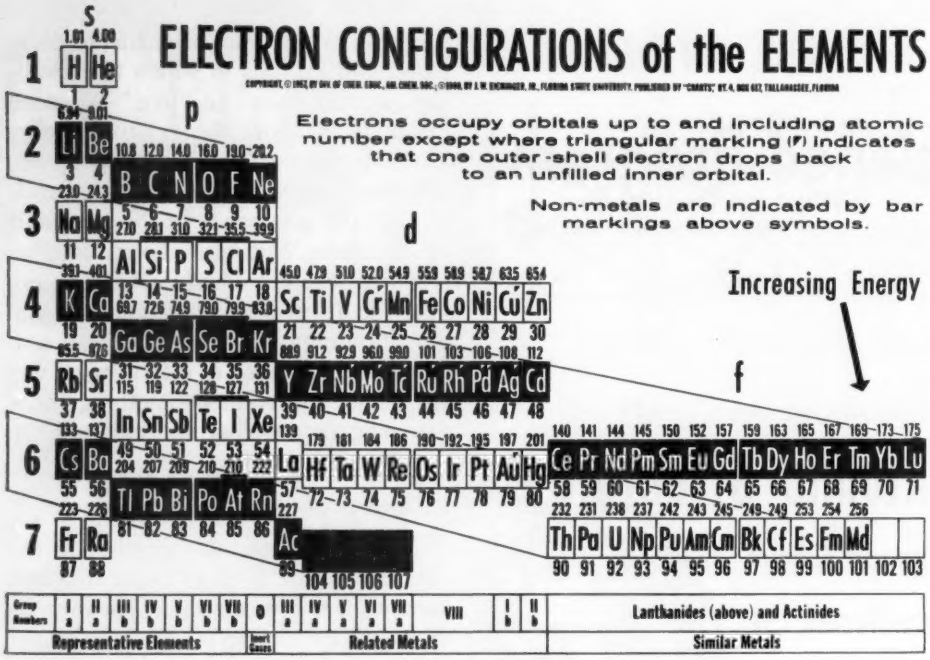


FIGURE 1. The Electron Chart.

chemical change is the purpose of the Electron Chart.

Plotting Energy Levels

The complex relationships between the various energy levels are most clearly portrayed by graphical methods. The Electron Chart uses squares to represent these energy levels. Energy is increasing downward and to the right on the chart. No attempt is made to plot energies according to any numerical scale. The positions portray only the relative energy values of the different subshells. This is sufficient to enable us to determine where all of the electrons belonging to the atoms of each kind of element "live" when the atoms are in their lowest energy state (the ground state). The main shells are represented by horizontal bands numbered 1 through 7 which slope downward to the right. The subshells are aligned vertically and designated by the letters *s, p, d,* and *f*. Notice that the 3*d* subshell is actually placed further to the right than the 4*s* subshell so that the overlapping energy values previously mentioned are clearly portrayed.

Orbitals and the Electron Chart

Two electrons in the same atom can move through the same volume of space with precisely the same energy provided that they are *spinning in opposite directions.* In other words, two electrons with opposed spins (an "electron pair") may occupy a single orbital. We would like to have a square to represent each energy level within an atom that may be "occupied" by an electron. This means that we will have to have two squares for each orbital, since under the proper circumstances each orbital can accommodate two different electrons.

The larger shells, which extend further from the nucleus, are able to accommodate more electrons than the smaller shells which are closer to the nucleus. When the Electron Chart is used to help "visualize" the electron structure of an atom, we imagine the nucleus to be located above the *upper left corner* of the chart. We imagine that we cut a wedge-shaped piece from the electron "cloud" which surrounds the nucleus in all directions and plot within the wedge the relative energies of all of the electrons belonging to the atom. Counting the squares belonging to different subshells, we find that all of the *s* subshells have two squares representing one single orbital, *p* subshells have six squares or three orbitals, *d* subshells have ten squares or five orbitals, while *f* subshells have fourteen squares or seven orbitals. Within a given shell, the capacity of the subshells increases as we move to higher energy levels (outward from the nucleus). The number of subshells found in each main shell also increases as we move outward from the nucleus (downward on the chart). Actually, the number of different subshells belonging to any particular main shell is the same as the shell number shown at the left of the chart. This relationship is obscured by the fact that only enough squares are provided to accommodate the electrons when the largest atoms are devoid of excess energy. The first shell shows just one subshell (1*s*), the second shell two (2*s*, 2*p*), the third three (3*s*, 3*p*, 3*d*), the fourth four (4*s*, 4*p*, 4*d*, 4*f*). But the fifth and higher numbered shells are not completely represented on the chart, because the spaces are not needed here as noted.

All of the squares belonging to a particular subshell represent exactly the same energy value. They have to be spread out horizontally but we do not wish to imply any difference in energy. This is one of the approximations that must be kept in mind. *Energy differences exist between different subshells, not within a particular subshell.*

You will notice that each subshell on the Electron Chart contains two separate blocks of squares. The 2*p* subshell, for example, consists of six squares divided into two groups of three squares each by a wide vertical space. We might think of this subshell as consisting of three "rooms." These are actually double rooms but whenever possible each electron will take a whole room for itself. Only when the subshell is crowded will they double up with a "roommate." We might use a college dormitory for a crude analogy. During summer school, with fewer students on the campus, each student might be allowed a private room. During the regular term, each would have to take a roommate.

The Mailbox Analogy

To better understand how to read the Electron Chart, let us elaborate somewhat on the "dormitory" theme. We will imagine that we are trying to house the electrons that belong to an atom in the best possible way. We want to give them the best rooms available. Our building is shaped like a pyramid. At the very top is a choice one-room penthouse while the lower floors become progressively larger but the rooms are less desirable. All the electrons want to live in the penthouse but unfortunately it will only accommodate two and the others must settle for less desirable quarters. (See Figure 2.)

Hydrogen has only one electron but the hydrogen atom is not a one-room house. *The hydrogen atom has just as many energy levels as any other atom.* However, only one of these "rooms" is occupied and, naturally, the electron will choose the choice room on the roof. We put a mailbox on the door and label it $_1$H.

Helium has two electrons and the capacity of each "room" (orbital) is two, so the second electron moves in with the first one and the penthouse is full. Since we already had a mailbox on the door, it is necessary to put a second mailbox on the same door and label it $_2$He for identification.

The second floor from the top of the building has a "presidential suite" (the 2*s* orbital) and three other rooms which are a little less desirable (three 2*p* orbitals). Lithium with three electrons puts two of them in the "penthouse" and the third one in the "presidential suite." Beryllium's four electrons completely fill both the 1*s* and 2*s* orbitals.

Boron has five electrons so one of them must "live" in the less desirable 2*p* subshell because the 1*s* and 2*s* subshells will be completely filled by four of the electrons.

Since there are three "rooms" (orbitals) available in the 2*p* subshell, the electron occupies one of the rooms and the other two remain empty. To keep track of the occupancy of our building, we put boron's symbol ($_5$B) on the mailbox on the door of the room. Carbon has one more electron than boron so its outer-shell electrons will occupy two of the "rooms" in the 2*p* subshell. The next mailbox is labeled $_6$C and this tells us that, in the case of carbon, two of the 2*p* orbitals contain single electrons while the third 2*p* orbital is empty.

Nitrogen has three electrons occupying the three orbitals singly and we put its symbol ($_7$N) on the third floor of the 2*p* subshell.

The next element is oxygen which has four electrons to be accommodated in the 2*p* subshell. The fourth electron must move in with one of the other three because only three rooms are available. Since we already have a mailbox and a name on every door, it is necessary to put a second mailbox on one of the doors. This is the significance of the second set of three squares to the right of the wide vertical space. They represent the second mailbox which we must have on each door for use by the second electron which may have to occupy each room when things get a little crowded. When we see $_8$O on the first square to the right of the wide space, we know that one of the three orbitals is doubly occupied while the other two contain single electrons.

The symbol for fluorine on the next square to the right is our clue to the fact that fluorine will have electron pairs in two of the 2*p* orbitals and a single electron in the other orbital.

Finally, neon in the sixth square has two electrons in each of the three orbitals and the 2*p* subshell is completely filled at this stage.

Writing Electron Configurations

The symbols for the elements have been placed on the Electron Chart in such a way that we can tell where all the electrons belonging to each element "live." All atoms of a particular element possess a number of electrons equal to the atomic number of that element. Normally, those electrons all try to get as close as possible to the nucleus. If an atom has 39 electrons, they are located in the energy levels represented by the first 39 numbered squares on the chart. One method for writing this information in a compact form is to use superscript numbers to indicate the number of electrons in each subshell. Oxygen atoms have a total of eight electrons. Two of these occupy the 1*s* subshell, two the 2*s* subshell, while the 2*p* subshell accommodates

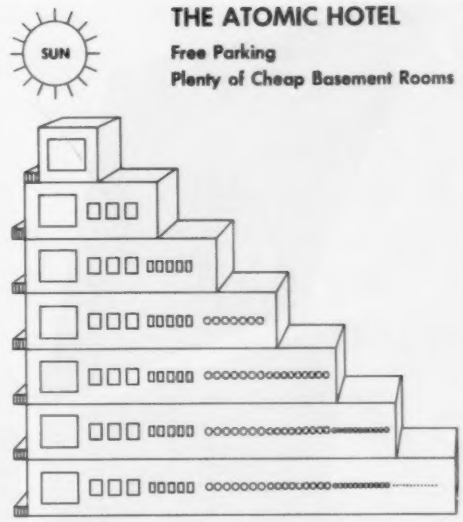
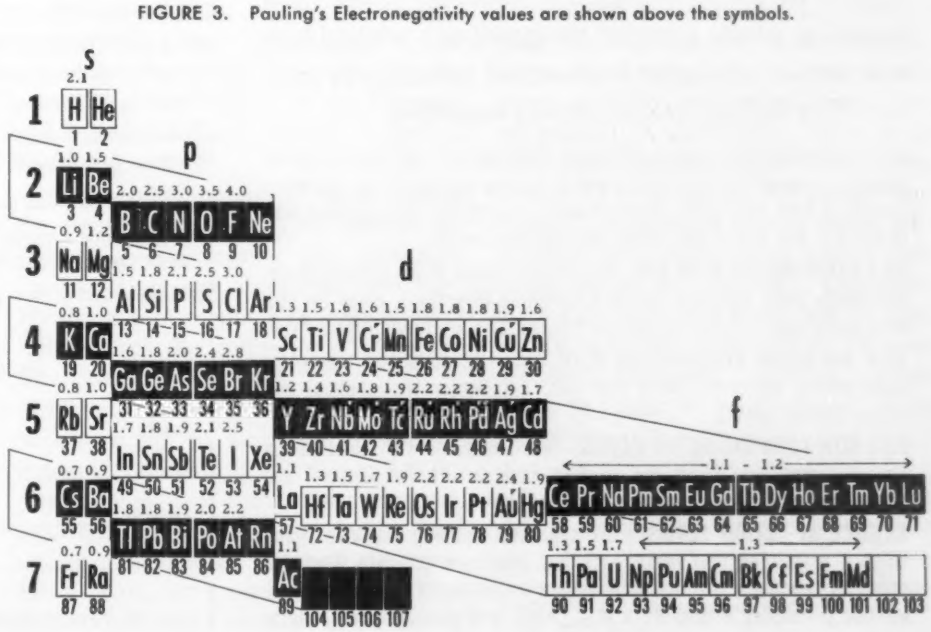


FIGURE 2. The "Mailbox Analogy" is illustrated in this example of the author's dormitory theme.

the other four. We can represent the electron configuration of oxygen as $1s^2\ 2s^2\ 2p^4$. Using the same symbolism, ytterbium has the configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^1\ 5s^2$. While this may look formidable, the procedure is quite simple and easily learned. With a little practice, students are able to write down the configurations of any of the known elements and even some that have not yet been synthesized.

Half-filled and completely filled subshells exhibit considerable stability and this is one of the factors leading to some so-called "exceptional" electron configurations. From a consideration of energy levels only, we would expect

FIGURE 3. Pauling's Electronegativity values are shown above the symbols.

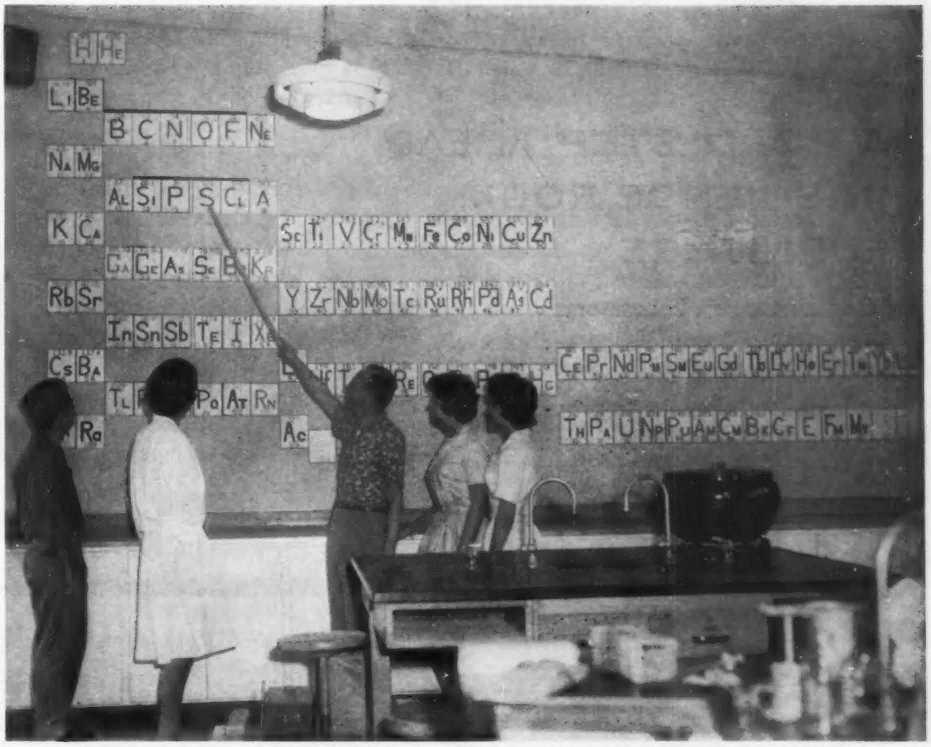


$_{24}Cr$ to have the configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ 4s^2$. However, the $3d$ subshell needs only one more electron to become half-filled. It takes one of the electrons from the $4s$ subshell and the ground state configuration of the last two subshells is $3d^5\ 4s^1$ rather than $3d^4\ 4s^2$. Whenever an outer-shell electron moves to an unfilled inner orbital in this manner, that fact is indicated on the chart by a small triangle (◤) placed in the square with the symbol for the element (See Figure 3). Two triangles are found with $_{46}Pd$ to show that the last two subshells should be written $4d^{10}\ 5s^0$ rather than $4d^8\ 5s^2$.

Types of Elements

The Electron Chart has certain advantages as a replacement for periodic tables. These include logical locations for hydrogen, helium, the lanthanides, and the actinides as well as a better over-all grouping of the elements for purposes of study. Many of the exceptions which have to be made concerning generalizations about the periodic table disappear. These generalizations apply well to the "Representative Elements," not to the "Related Metals" or the "Similar Metals." The eighteen-column periodic tables in common use obscure these relationships by separating the representative elements, placing some at the left of the table and others at the extreme right.

Note that in the "Representative Elements" portion of the chart, the symbols are located in squares which represent the outermost electron shell of each atom respectively. The situation is very different in the "Related Metals" and "Similar Metals" portion of the chart. Take scandium, for example; the symbol $_{21}Sc$ is found in the $3d$ subshell, but notice that two of scandium's 21 electrons "live" in the $4s$ subshell. For all related metals, we find that the symbols of the elements have been placed in the next-to-the-outermost electron shell. Comparing the electron structures of horizontal neighbors, we see that the outermost electron shells are alike but that there is a different number of electrons in the next-to-the-outermost shell. Since the outer electron shells have the greatest effect on the chemical properties of elements, it is not surprising to find that $_{26}Fe$, $_{27}Co$, and $_{28}Ni$ show rather closely related properties. They have identical outer electron shells and differ only in the next-to-the-outermost electron shell. Because of their *closely related properties,* the elements in this central portion of the Electron Chart are called *related metals.* All are metals, and horizontal neighbors tend to resemble each other. This was not the case with the representative elements.



This "world's largest" Electron Chart was made in 1958 by the students in the second-year chemistry class at Choctawhitchee High School, Shalimar, Florida. James G. Evans (teacher) is explaining the subshell structures of the representative elements demonstrated by the chart to high school students.

The resemblance between the similar metals is even more striking because the structural differences between horizontal neighbors now lie in the second-from-the-outermost electron shell. Because they have two identical electron shells near the surface of their atoms, their chemical properties are found to be quite *similar.*

Nonmetals are found only among the representative elements and are restricted to a triangular area indicated by bar markings above the symbols. Borderline elements near the sloping left edge of the nonmetal triangle are often called "metalloids."

Other important types of elements which do not fit well into any of the categories previously mentioned are the "inert gases" and that unique element, hydrogen, which has no family and defies classification. In using the Electron Chart, one must remember that helium ($_2He$) is a member of the family of inert gases. It was necessary to separate it from the other members of the family in order to depict its electron configuration properly. On the chart, the symbols for hydrogen and helium have been displaced slightly to the right to remind one of the fact that they do not belong to Groups Ia and IIa respectively.

Electronegativity Values

Pauling [6] has proposed an arbitrary scale of numbers for comparing the electron-attracting tendencies of the atoms of different elements when they are present in compounds. These numbers, called "electronegativities," range from 0.7 for cesium to 4.0 for fluorine. Figure 3 shows an Electron Chart with Pauling's electronegativity values indicated for all the elements. Generally, the values increase from left to right and from bottom to top in the "Representative Elements" portion of the chart. It might be worthwhile to study the variation of these values in different portions of the chart and memorize a few important ones. The values from $_3Li$ to $_9F$ are quite easy to remember.

[6] L. Pauling. *The Nature of the Chemical Bond.* Third Edition. Cornell University Press, Ithaca, New York. 1960. p. 93.

They start with 1.0 for lithium and increase by 0.5 for each element until fluorine (4.0), the most electronegative of all elements, is reached.

The electronegativities of the related and similar metals show some interesting relationships. It is worth noting that the only ones having values over 2.0 are the members of the platinum family (Ru, Rh, Pd, Os, Ir, Pt) and gold.

As a rough guide, bonds between atoms which differ in electronegativity values by 1.7 units or more are essentially ionic. If the difference in electronegativity is 0.5 or less, the bonds are essentially covalent. In between, we have varying degrees of "polarity." Strictly "non-polar" covalent bonds having the electron pairs shared equally between the two atoms are only to be expected when the electronegativities are identical as in the hydrogen molecule, H_2, for example.

Oxidation Numbers

It is often possible to predict the more important oxidation states of an element from its electron configuration. Consider, for example, elements numbered 19 through 30 (potassium through zinc). It is not necessary to write out the configurations if you can visualize them while looking at the chart. It is noted that $_{19}K$ can achieve the $_{18}Ar$ electron configuration by losing one electron to produce the K^+ ion. Further ionization does not occur in chemical reactions because there is never enough energy to take an electron away from the stable argon structure. For similar reasons, calcium loses two electrons and scandium three to form the Ca^{++} and Sc^{+++} ions.

The elements numbered 22 through 29 show variable oxidation states. The small triangle indicates a $3d^{10}\ 4s^1$ outer structure for copper and the loss of the $4s$ electron leads to the copper (I) or cuprous ion, Cu^+. While there is a certain degree of stability associated with a completely-filled *d* subshell, it is much less than that of a completely-filled *p* subshell (inert gas structure). A second electron is always more difficult to remove from a metal atom than the first one because it has to be pulled away from a particle which already has an excess of positive charge. Similarly, the removal of a third electron is still more difficult (requires more energy). It turns out that it is possible to break up a completed *d* subshell to obtain a second electron and produce doubly-charged metal ions but it is not possible to do so for a third electron. This is the reason that +2 is the only known oxidation state for zinc (except zero) while copper can be forced into a +3 state in some compounds. All the elements from 22 through 29 exhibit both +2 and +3 oxidation states.

The complete removal of a fourth electron from a metal atom would require so much energy that it probably never happens in ordinary chemical reactions. Such ions are known to exist only in "plasmas" which are vapors heated to extremely high temperatures. When we speak of higher oxidation numbers than +3 we are referring to covalent bonding and the "partial removal" (sharing with other atoms) and not the complete removal (ionization) of electrons. It is helpful to remember that, for purposes of computing oxidation numbers, it makes no difference whether electrons are completely lost or only partially lost by sharing with other atoms which have higher electronegativity values.

At times, the extra stability of paired electrons is sufficient to account for the maximum oxidation states exhibited by atoms. Titanium has a maximum oxidation state of +4, vanadium +5, chromium +6, and manganese +7. The maximum oxidation state of iron, however, is only +6. Cobalt seems to be +4 although +5 looks theoretically possible, nickle is +4, copper +3, and the maximum oxidation state of zinc is found to be +2.

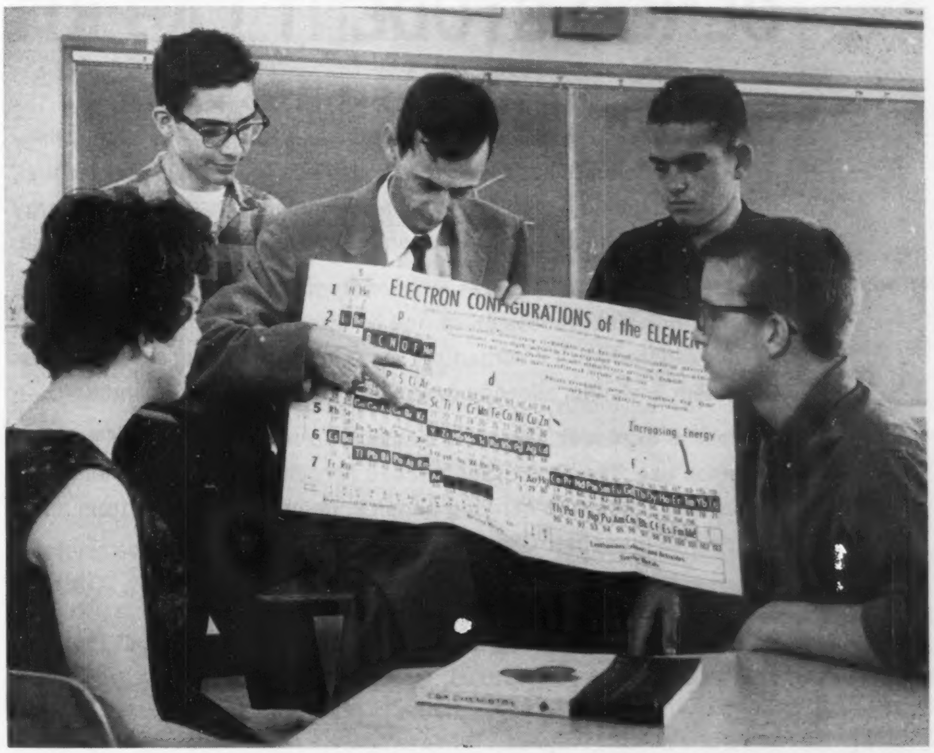
Other factors such as particle size and charge density are sometimes of overriding importance and, of course, there are other types of bonding that could be considered. One can go as far as circumstances will permit. The point is that a student with this kind of introduction to atomic structure has a firm foundation upon which to build. He is better prepared for chemistry as it is now being taught at the higher levels.

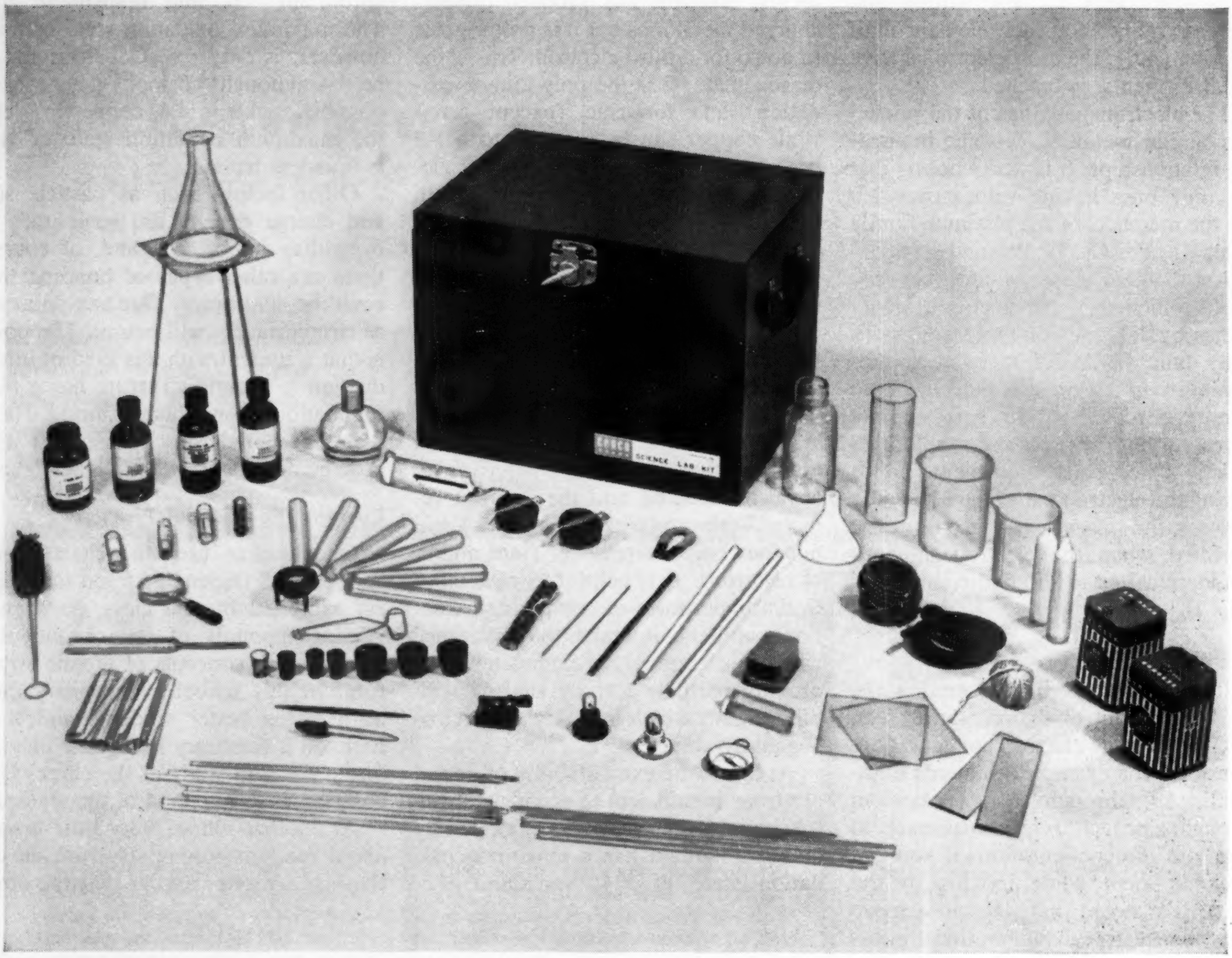
Current High School Practices

One teacher uses the chart as an "appetizer." Depending upon the interest exhibited by the class, he spends varying amounts of time broadening the textbook concepts of atomic structure. In this school, a chemistry club attracts the better students and it is here, on a voluntary basis, that they go into a detailed study of the chart. This contributes to retention of the material.

At another school, very little is said about modern atomic structure during the first semester except that the atom

Paul Bethune of University School, Tallahassee, Florida, finds the Electron Chart useful in helping students understand modern atomic structure in his Chemical Bond Approach course.





is not as simple as usually pictured. An Electron Chart is hanging on the wall as "bait" for the intellectually curious. As the brighter students are spotted, they are given the book[7] for personal study. In the second semester when nuclear reactions are discussed a return is made to atomic structure and one or two class sessions are devoted to a presentation of the chart.

Some schools introduce the Electron Chart at the same time as the periodic table and emphasize the subshell structure wherever it is useful throughout the remainder of the course. One teacher uses the chart as the unifying concept behind his entire course but goes into more detail with his honors classes than with his regular classes.

Another plan introduces the chart even earlier in the course along with atoms and molecules. Symbols of some common elements are memorized and then located on the chart. Thereafter, the chart is used constantly to the exclusion of the periodic table and every effort is made to relate properties of the elements to structure.

A number of teachers are planning in future courses to place greater emphasis on electron cloud shapes, the directional characteristics of covalent bonds, and the shapes of molecules.

It is evident that the next few years will see a great deal of healthy experimentation in the teaching of high school science. The newer concepts of atomic structure and chemical bonding must be introduced to beginners in simplified form but skillfully enough so as not to implant wrong impressions in their minds. To quote one teacher directly, "Chemistry, to me, is much more meaningful when the student is made to depend more upon his thought processes and less upon memorization of large masses of knowledge. The Electron Chart is useful in making a student think rather than memorize."

[7] Jack W. Eichinger, Jr. *Surveying the Elements with the Electron Chart.* The Florida State University, Tallahassee, Florida. 1959. Available from the publisher to schools at 90 cents per copy. Order from Charts, Route 4, Box 617, Tallahassee, Florida.

• • • *Rebuilding the Science Program* • • •

General

The Laboratory and Science Teaching

By MILTON O. PELLA

Professor of Science Education, University of Wisconsin, Madison, Wisconsin

THIS laboratory experiment or exercise refers to an instructional procedure in which cause and effect, nature or property of any object or phenomenon is determined by individual experience generally under controlled conditions. Laboratory activities are often defined to include demonstrations as well. Although, to some the differentiation between laboratory activities and demonstrations is artificial; in this discussion laboratory activities are to be considered as individual or small group activities. A subject topic of concern in science is selected, and a teacher provides the necessary guidance.

Analysis of high school textbooks and laboratory workbooks in the several sciences and interviews with 140 teachers of science, reveal the following functions which are related to laboratory activities:

1. A means of securing information.
2. A means of determining cause and effect relationships.
3. A means of verifying certain factors or phenomena.
4. A means of applying what is known.
5. A means of developing skill.
6. A means of providing drill.
7. A means of helping pupils learn to use scientific methods of solving problems.
8. A means of carrying on individual research.

It is obvious that each function is important and directly related to the nature of the desired learning outcomes. Further, it may be inferred that the presence of laboratory activities in the teaching of science depends upon the goals of instruction.

Review of courses of study or curriculum outlines from twenty-two states and/or individual school systems with an eye for classifying the purposes for teaching science in the schools reveals that the objectives fall into seven categories:

1. Understanding the course content of science.
2. Learning the methods of science.
3. Developing scientific attitudes.
4. Developing the desirable social attitudes.
5. To stimulate interest in science.
6. To learn how to apply the principles of science.
7. To develop an appreciation for the growth and development of scientific knowledge.

Review of this list of objectives and the list of functions of the laboratory reveals a startling similarity and an apparent relationship. This is to be expected since the objectives are the products of investigation and the functions refer to the processes by which one arrives at the product.

The presence or absence of laboratory exercises does not guarantee the realization or lack of realization of the goals. The results achieved in the laboratory depend upon the way it is used. Further, the way the laboratory is used depends upon the assumed position of the teacher in the teaching-learning process. The teacher may assume either of two opposed positions or compromise with some position between the two extremes.

At one extreme, the teacher assumes a position as the dispenser of knowledge with the laboratory serving the function of drill (reinforcement) or verification. At the opposite extreme, the teacher assumes the position of a guide to learning and the laboratory as a place where knowledge is discovered. The teacher's position then becomes

apparent immediately as one observes what use of the laboratory is made.

Securing Information

In the process of securing information through the use of the laboratory common steps are found. The following are recognized as the "type form" given for scientific problem solving:

1. Statement of problem.
2. Formulation of hypotheses.
3. Developing a working plan.
4. Performing the activity.
5. Gathering of data.
6. Formulation of conclusions.

It is immediately obvious that these steps are not found in most laboratory manuals. The steps commonly found in laboratory manuals are: purposes, apparatus, procedure, data, and conclusions. Note that the formulation of hypotheses is absent. The purpose, apparatus, and procedure are completely described in the manual. The method of treating the data is described and the pupil generally reads the conclusion from the textbook. The only steps in the total procedure left to the pupil are the performing of the activity and the gathering of data. This procedure need not be the only one performed.

In the utilization of the laboratory to help pupils gain an understanding of information, there are five degrees of freedom available to the teacher. These degrees of freedom are in the relative amounts of responsibility assumed by the pupils and the teacher. In Table A, in the column denoting Procedure I, note that the teacher performs Steps 1, 2, 3, and 6 and the pupil performs Steps 4 and 5. Objection may be voiced by some teachers to the statement that the teachers formulate the conclusions for the pupils. It may not be recognized immediately that the statement of the purpose very often provides the statement of the conclusion; *i.e.,* Purpose: To show that the resultant of two forces is equal to the equilibrant but opposite in direction. The answer and the limits of the answer are stated in the purpose.

In Procedure II, the pupil is asked to formulate conclusions as well as perform the experiment and gather data. This can be achieved by the utilization of laboratory activities concerned with problems without answers in the textbook; *i.e.,* "What is the effect of the concentration of certain drugs on the heart beat of the dophnia?" Notice that added to information is at least one additional step commonly found in scientific problem solving; drawing conclusions from data.

TABLE A

Degrees of Freedom Available to the Teacher Using the Laboratory

Steps in Procedure	I	II	III	IV	V
1. Statement of Problem	T	T	T	T	P
2. Hypotheses	T	T	T	P	P
3. Working Plan	T	T	P	P	P
4. Performance	P	P	P	P	P
5. Data Gathering	P	P	P	P	P
6. Conclusion	T	P	P	P	P

T — Teacher P — Pupil

Procedure III provides opportunity for the pupil to exercise some creativity in the development of techniques of testing hypotheses. The pupil must now decide what controls and variables he will have in his experiments, what kinds of data to collect, and how the data are to be treated. The teacher poses the problem and the hypotheses. Of course, the teacher must serve as a guide so that procedures dangerous to the physical welfare of the pupil are avoided.

EXAMPLE:

Problem: What purpose or purposes does the cocoon serve in the metamorphosis of a moth?

Hypotheses: Keeps pupa from drying out. Protects the pupa from physical injury. Protects the pupa from light. Stimulates the secretion of some growth-regulating substance.

Again the benefits of the laboratory are expanded to contribute to several of the objectives for teaching science in addition to that of gaining information. This is true for all procedures other than the first; however, they differ in the degree to which the contributions are made.

If *skill development* is the objective, the teacher will employ Procedures I or II.

The *methods of science* are generally approached in Procedures IV and V.

Individual research is carried on when the activities of the pupil parallel the steps in Procedure V.

The laboratory and inductive teaching. Much of the time in the teaching of science is devoted to helping pupils develop an understanding of science principles. Understanding implies knowledge of facts supporting the generalization and the relationship of the facts to each other so that common factors or trends can be ascertained.

If pupils are to learn how to employ the inductive methods of inference, they must be provided with opportunities to make inferences from facts. The laboratory is one place where facts are collected in a variety of ways.

If a teacher agrees with these statements, he will plan for the laboratory phase to occur early in the teaching-learning sequence. It will generally precede the teacher telling, describing, or the textbook-reading phase.

The laboratory and deductive teaching. If the teacher believes that the primary function of the science class is to transmit the factual heritage of a civilization or that deductive reasoning is most important, he will use the laboratory as a place for verification. The laboratory phase here will follow the teacher description or the textbook-reading phase.

The teacher and the laboratory. The position the laboratory holds in the procedures of a given teacher depends upon what function that teacher holds for himself in the teaching-learning process and the nature of the content being taught. Care must be exercised continually so that the process does not become the only end product. Processes are important only to the degree that they help to produce a product. The products in the teaching of science are knowledge and how knowledge evolves.

Science Research in the High School

By FLAVIN J. ARSENEAU

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This report was an entry in the STAR (Science Teacher Achievement Recognition) awards program of 1960, conducted by NSTA and sponsored by the National Cancer Institute, U.S. Public Health Service.

THE specific purpose of this research project is to determine if the interest of high school students in the choice of a career can be stimulated by introducing basic research in the curriculum of the biological sciences. To evaluate the project, procedures are set up to observe the students during the testing. Frequent individual progress checks are made as well as constant evaluation and knowledge of the student's work in college at a later date. Due to the long period of training, the intensity of the instruction and the individual work required of each student in the project, it is necessary to keep the group small.

Research Design. The *control* group, non-stimulated, consisted of twelve or more high school seniors who had taken the maximum amount of science courses available with no grade in science below *B*. This group did not participate in any extracurricular activities in the field of science. During their senior year they were given questionnaires to fill out stating their future plans. Those students who indicated a desire for a career in science, especially those in the biological sciences, received annual questionnaires during their college careers. Where possible, random selection was used in choosing the control group.

The *treatment* group, stimulated, consisted of twelve students from high schools throughout the Fort Worth Independent School District. Four sophomores and four juniors were selected the first year with four sophomores added the second year. Each year four seniors graduated and four additional sophomores were added to the group. Where possible, random selection was used. The size of the treatment group was determined by the ability of the principal investigator to successfully supervise their indoctrination and research program, by the amount of space available, and by budget limitations.

The treatment group's laboratory work convened on each Friday after school and all day Saturday during the school year. Other days were utilized as the occasion demanded. Summer work was based on majority need and availability. Original research was conducted by each student after sufficient secondary research in his particular area had been completed. Complete records were kept on their progress and achievements. Presentation of papers, display of work through science fairs, and checking college progress also became part of the program.

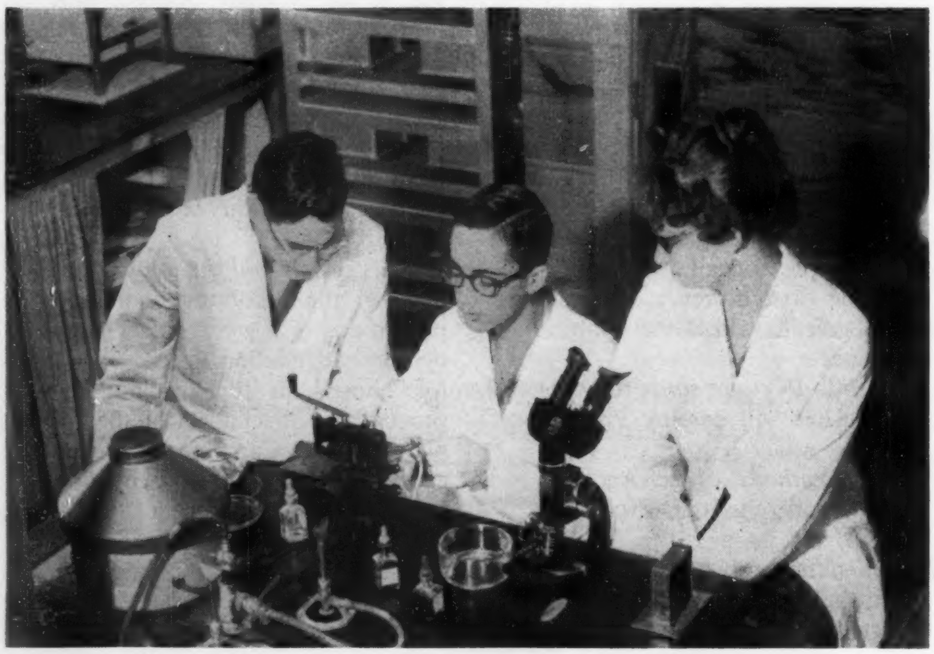
A comparison analysis of the two groups, control and treatment, was made periodically and a conclusion drawn of the effects and success of this research upon its termination. This research covered a five- to eight-year period of study and observation.

Physical Equipment. The laboratory for conducting this research was a converted frame classroom building, 24 x 63 feet; facilities for electricity, gas, and water were adequate. In general, the inventory and availability of equipment, chemicals, and other supplies were no problem since grant funds had been provided by the National Institutes of Health. Proper care and usage of equipment and other material were emphasized, but not any check-in, check-out system was used for the treatment group. Thus, they enjoyed complete freedom in the use of laboratory supplies and equipment. (Figure 1.)

Methods and Procedures. In order that interested students might know what the program had to offer, publicity was obtained from the local newspaper

NOTE: The author initiated this project as Principal Investigator under a research grant from the National Institutes of Health.

FIGURE 1. A checking-out process on the use of the Clinical Microtome in research laboratory is done by students Jimmy Joiner, Philip Anthony, and Jeannina Fox (l. to r.) as part of their class activities.



concerning the general plan of the research program. A follow-up was made by sending self-explanatory application forms to specific science teachers in the school system. Classroom announcements were made, and several high schools gave publicity to the program over their public address systems during the morning announcements. Applications from students, upon receipt by the principal investigator, were examined and each applicant telephoned to set a time for personal interviews.

An investigator-constructed check list was kept during the interview with each student. This check list was divided into two groups—essentials and non-essentials. Each question or area on the list was rated from zero to four. A zero score on any area in the essentials would eliminate the applicant. The primary objective of the interview and check list was to obtain information about the applicant. Eighteen areas were covered on the check list with a maximum score obtainable of seventy-two possible as a total.

Because information was lacking on any intensive studies made on how to select people for training to produce a basic research scientist, especially in the biological field, the following series of tests were selected:

1. Otis Quick-Scoring Mental Ability Tests; and Gamma Test: Form C.
2. Sequential Tests of Educational Progress (STEP); and Level 1: Form B.
   a. Reading
   b. Mathematics
   c. Science
3. Kuder Vocational Preference.

Research Training Program. An indoctrination program of about two weeks was given to the students selected for the program. This entailed a discussion of general laboratory rules, safety precautions, and the nature of research work including philosophy and specific detailed instructions. A check-out demonstration concerning the care and usage of major pieces of equipment was given at intervals during the indoctrination phase. Group counseling, which pertained to the importance of secondary research prior to laboratory research, introduced the students to the laboratory's technical library.

Individual counseling and idea projection was used to aid the student in selecting a research problem and purpose. Later a review was made of each student's progress through examination of his secondary research notes, tentative research designs, and a check to insure his knowledge of the proper usage and care of equipment needed to conduct his chosen research. Finally the student was guided to do some exploratory work prior to his research investigation, and is left to work independently on a project. (Figure 2.)

If the above results proved satisfac-

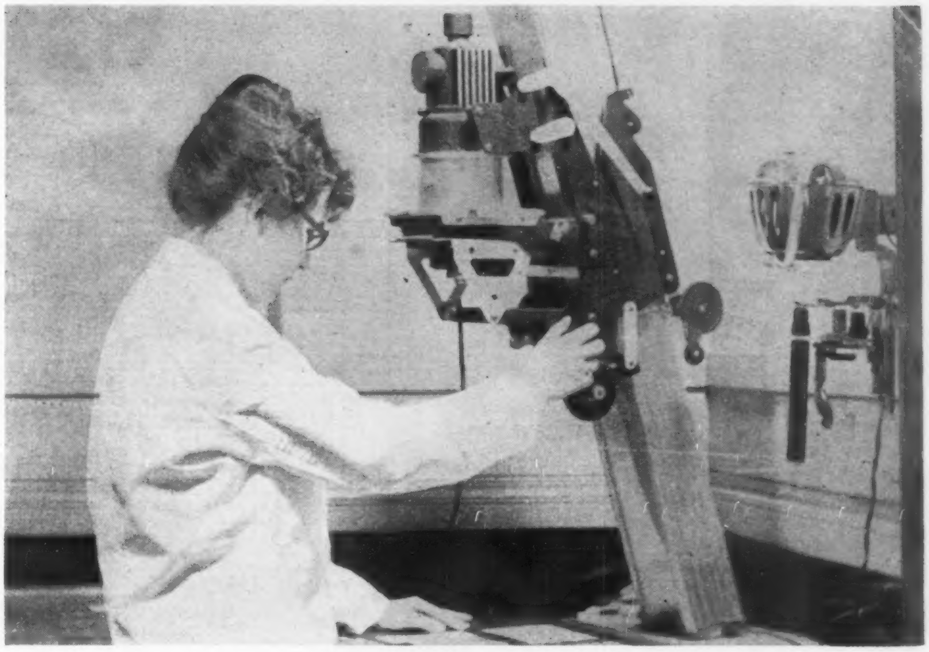


FIGURE 2. Jeannina Fox is shown using the enlarger in the darkroom.

TABLE I

Treatment Group—Selection Results

Student	Age	Grade	Sex	Interview	IQ	Science	Mathematics	Reading	Kuder
B, R	15	10	M	67	112	Raw 39 % 86-97	Raw 22 % 40-82	Raw 36 % 14-30	8-70-98% 3-58-96%
D, B	16	11	M	64	130	Raw 41 % 91-99.5	Raw 28 % 72-95	Raw 62 % over 100	3-62-99% 2-46-96%
H, C	16	11	M	58	132	Raw 43 % 94-99.7	Raw 24 % 52-89	Raw 55 % 74-95	3-59-97% 6-26-77%
*L, L	14	10	F	57	129	Raw 31 % 50-80	Raw 22 % 40-82	Raw 56 % 79-96	3-54-95% 0-56-94%
M, L	16	11	M	55	121	Raw 34 % 69-90	Raw 19 % 30-63	Raw 45 % 34-59	3-56-94% 9-49-62%
M, G	14	10	F	64	124	Raw 29 % 40-72	Raw 15 % 16-41	Raw 41 % 26-40	3-67-100% 2-51-99%
*P, E	14	10	M	55	126	Raw 45 % over 100	Raw 29 % 78-96	Raw 47 % 37-66	3-69-100% 2-40-90%
*P, B	15	10	M	59	136	Raw 44 % 95-99.8	Raw 36 % 96-99.7	Raw 47 % 37-66	3-65-99% 2-34-74%
R, B	16	11	M	68	124	Raw 43 % 94-99.7	Raw 27 % 72-95	Raw 52 % 54-87	3-62-99% 0-75-98%
S, C	15	10	M	54	114	Raw 35 % 72-92	Raw 21 % 36-78	Raw 35 % 11-26	3-58-96% 0-70-96%
*T, CL	15	10	M	63	116	Raw 32 % 57-85	Raw 30 % 87-97	Raw 40 % 26-40	3-66-99% 0-63-89%
W, D	16	10	M	70	109	Raw 31 % 50-81	Raw 19 % 30-63	Raw 45 % 34-59	3-55-92% 5-37-91%

* Represents those students who were the last group selected at the time of this report.

tory to the principal investigator, the student was then qualified and encouraged to begin his laboratory research work. Actual assistance given the student while conducting his research in the laboratory was kept at a minimum. Suggestions were favored as the principal form of assistance. When needed, laboratory techniques were demonstrated both individually and to the group. After the student had been engaged in his research and obtained a good grasp of experimentation, the primary function of the principal investigator shifted to supplying the student with research needs (Figure 3).

Guidance to each student into a particular research problem depended on his own ability, resources available, time available, and future field of interest. Investigation of the student's records and observations was continuous during his research. When the research terminated, an individual discussion and analysis of his work were conducted. Then he became introduced to a more difficult problem that challenged his increased knowledge, confidence, and curiosity. Personal pride and ambition were stimulated through recognition of the student's research and abilities by various professional and semi-professional organizations and related activities.

Progress Report. This report covers the first nineteen months of the project. The full complement of students for the research program had been obtained. The science, mathematics, and reading tests in Table I are based on Level 1, Form B, of the STEP tests. Norms used for determining percentile bands are those of the publisher, prepared for grade 13.

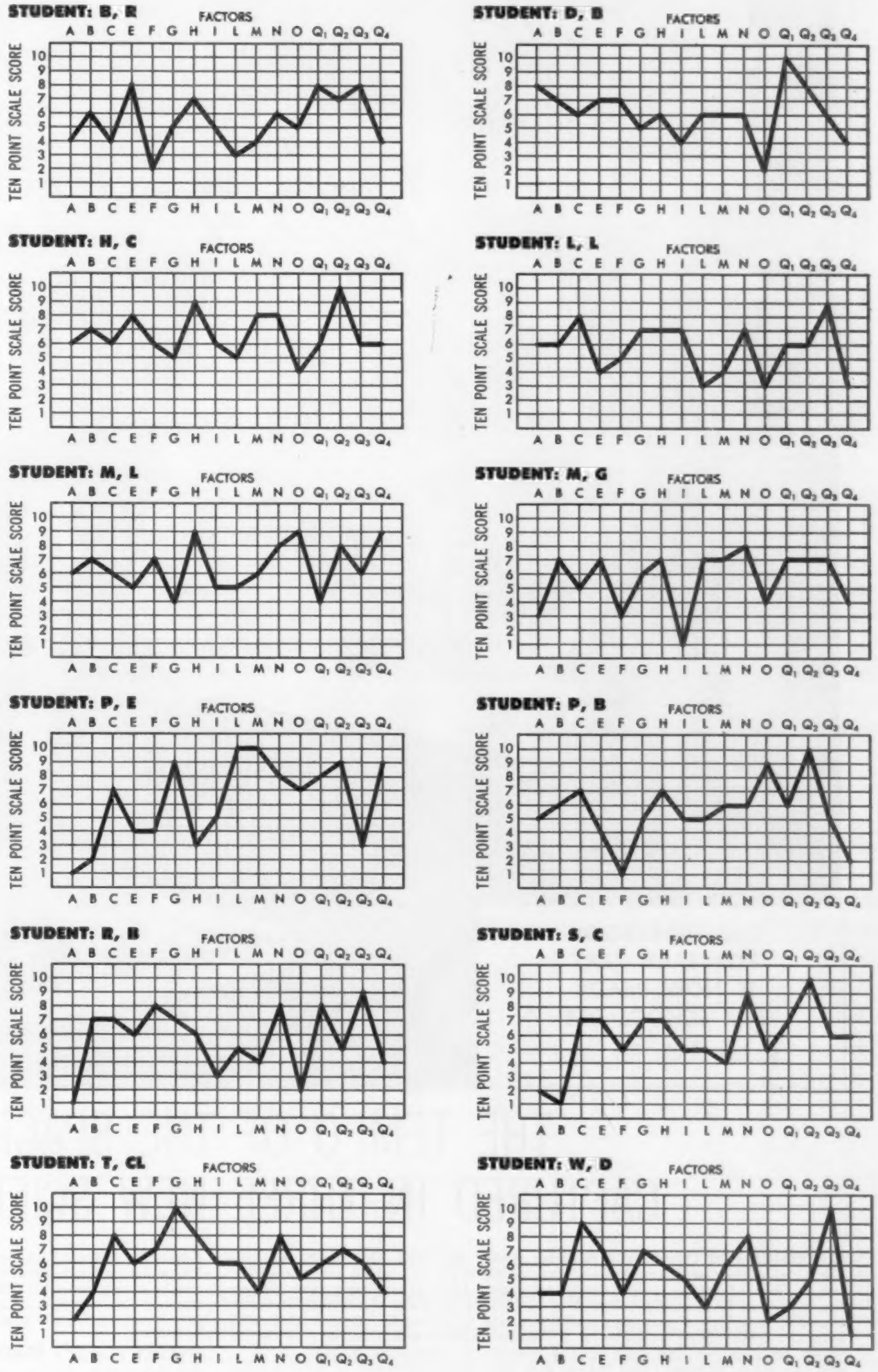
The IQ was obtained from the Otis Quick-Scoring Mental Ability Test and Gamma Test, Form C.

The primary members of the treatment group (non-asterisked) had received nineteen months inculcation in the science of basic research. Four students in this group successfully completed research problems and the remaining members were in various stages of their investigation. Typical research problems that had been completed or were in progress:

TABLE II

Visual Profiles—16 P.F. Test

Publisher's Standardization Tables: Form A—Table 1 Men, 2 Women
Standard Ten Score: American College Students



1. *Problem:* Determination of the Growth and Differentiation Properties of the Melanophores of the Chick, "in vitro," as Determined by Tissue Culture and Intro-Embryonic Grafting.

   Purpose: To determine the growth and differentiation properties of the melanophores of the Australorp, New Hampshire Red, and White Leghorn breeds of chicks.

2. *Problem:* Culture of the Embryonic Chick Femur in a Plasma-Embryo Extract Clot, White's Synthetic Nutrient, and Richerson's Synthetic Nutrient, "in

vitro." (Richerson's nutrient was student synthesized.)

Purpose: To determine which medium tested will support the best growth of embryonic chick femur.

3. *Problem:* The Grafting of 3-Day Chick Embryo Limb Buds to a 3-Day Chick Embryo and to a 10-Day Chick Chorio-Allantoic Membrane.

   Purpose: To determine which type grafting will give maximum growth of the transplant over an 8-day incubation period.

4. *Problem:* Cultivation of Rhabdomyosarcoma from CE Mice in a Medium Containing the Cultural Filtrate of "S. schenkii," "in vitro."

   Purpose: To determine the effect of the cultural filtrate of "S. schenkii" on the growth and cell structure of rhabdomyosarcoma from CE mice, "in vitro."

5. *Problem:* To Determine the Extent to which Phenylthiourea Will Inhibit the Production of Melanin in the Developing Embryo of the Black Australorp Breed of Chick.

   Purpose: To determine the quantity and concentration of phenylthiourea that is most effective in inhibiting the production of melanin or pigment granules.

All of the above research reports placed in the Fort Worth Regional Science Fair, and Number 1 tied for first place at the National Science Fair in 1959. Number 4 won a fourth place at the 1960 National Science Fair. The progress of each research report was kept in the form of a bar graph which was placed in a prominent place in the laboratory. This detailed chart served as a stimulus to the student and allowed group progress to be ascertained at a glance by all interested.

Since not enough applicants survived the eliminating process of the selection criteria, the control group could not have been obtained by random selection. The last control group consisted of eleven high school seniors that received the maximum science courses offered, *B* or better in their science grades, and had not participated in any extracurricular activities in the field of science. As the research project continues, each year a new control group will be selected, and each year of college that the group completes will be

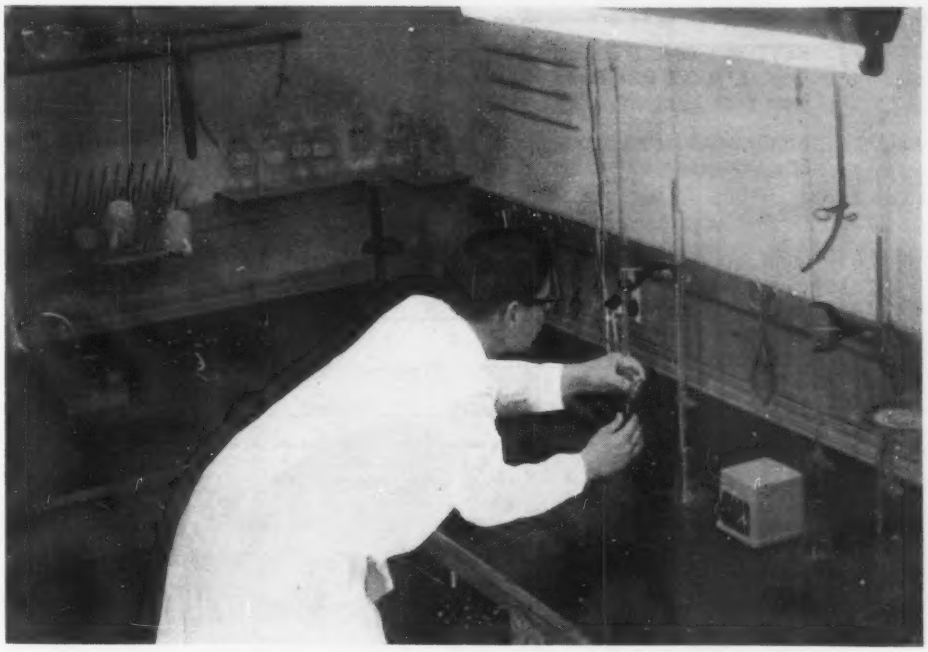


FIGURE 3. A titration study in a chemistry project is performed by Dave Snipes.

checked as to career intention and general academic standing. This "follow-through" will be applied to the treatment group, and a comparison will be made between the two.

Supplemental Selection Data. Since the method of selecting the student who will become a basic research scientist is the primary objective of this research, this area is constantly being re-evaluated and revised with improvement as a goal. Recently, the treatment group was given the 16 P.F. Test, prepared by the Institute for Personality and Ability

TABLE III

16 P.F. Test Range

Factor	Range	Factor	Range	Factor	Range
A	3 - 7	H	5 - 7	O	2 - 3
B	5 - 7	I	3 - 6	Q_1	6 - 9
C	6 - 9	L	4 - 6	Q_2	5 - 8
E	5 - 7	M	4 - 6	Q_3	7 - 9
F	5 - 7	N	6 - 8	Q_4	2 - 4
G	5 - 8				

TABLE IV

Ability—Achievement—Interest Test Range

(Formulated from selection tests utilized in this research.)

	Otis IQ	STEP Science	STEP Mathematics	STEP Reading	Kuder Preference
Sophomore	120 & Up	50% & Up	35% & Up	50% & Up	3 . . . 95% & Up
Junior	120 & Up	85% & Up	68% & Up	50% & Up	3 . . . 95% & Up

Testing, for the purpose of establishing a personality-factor range based on those personality factors tested for by this test. A visual profile was prepared for each student in the project. (See Table II.) Students W, D; L, L; R, B; and D, B were used in preparing a personality factor range to be used in future selection of applicants. This range will be utilized in addition to the other tests given to applicants and will become the major criterion in the selection program. It will serve also as one of the major devices for determining what makes a basic research scientist. It is expected to reveal some of the intrinsic factors of those students who show the most progress in basic research work, such as the four students used in making this initial personality factor range.

In brief, the 16 P.F. Test measures the following factors:

Factor	Low Score Description	High Score Description
A	Aloof, Cold	Warm, Sociable
B	Dull, Low Capacity	Bright, Intelligent
C	Emotional, Unstable	Mature, Calm
E	Submissive, Mild	Dominant, Aggressive
F	Glum, Silent	Enthusiastic, Talkative
G	Casual, Undependable	Conscientious, Persistent
H	Timid, Shy	Adventurous, "Thick Skinned"
I	Tough, Realistic	Sensitive, Effeminate
L	Trustful, Adaptable	Suspecting, Jealous
M	Conventional, Practical	Bohemian, Unconcerned
N	Simple, Awkward	Sophisticated, Polished
O	Confident, Unshakable	Insecure, Anxious
Q_1	Conservative, Accepting	Experimenting, Critical
Q_2	Dependent, Imitative	Self-Sufficient, Resourceful
Q_3	Lax, Unsure	Controlled, Exact
Q_4	Phlegmatic, Composed	Tense, Excitable

See Tables III and IV for the criteria to be used in the selection program of current and future research in the area being investigated. Modification of the selection criteria will be made as additional information warrants such revision to be completed.

Efforts are being made to publicize the results of this project in every way possible. As more data becomes available, it is hoped to have it disseminated to those interested in the program.

Classroom IDEAS

Biology

Crude Drug Media Effect on Fungi Cultivation

By ARNOLD I. MILLER, Thomas Jefferson High School, Brooklyn, New York

During participation in a research program for high school teachers under a National Science Foundation grant at Saint John's University, work was completed in various specific areas of biology and chemistry.

My research participation involved the field of microbiology, particularly mycology, and was directed by Dr. Michael A. Pisano of the Biology Department.

This project lends itself to individual and/or group work in the high school laboratory. It is neither too easy nor too difficult for able pupils. The materials are easily acceptable and are comparatively inexpensive. Results can be obtained within twenty-four hours after inoculation and incubation, with the entire duration of the project lasting at least two weeks. High school students experience greater pleasure and exhibit a higher level of interest when they can actually see results from their work in a short period of time. This project is especially adapted to this factor.

By adding various crude drug extracts to basic fungal media many interesting and unusual observations can be made. This experience can also be performed with bacteria as the organisms of choice. The simplified procedure is described herein.

The amounts given below are for 250 cc of the media. The figures can be adjusted to suit individual needs.

1. Twenty-five grams of a crude drug (various common spices and medicinal products) are macerated thoroughly using a mortar and pestle (an electric food blendor is ideal, if available, and handled carefully.)
2. Add 250 ml of tap water to the crude drug and mix thoroughly.
3. The entire mixture is brought to boiling and allowed to simmer for twenty minutes.
4. Cool the mixture to room temperature.
5. If a centrifuge is available, centrifuge the mixture at 2000 rpm for twenty minutes. If a centrifuge is not on hand, allow the coarse particles to settle and pour the supernatent liquid into a 250-ml graduate.
6. Restore the volume of the supernatent liquid to 250 ml using ordinary tap water.
7. At this point, the crude drug extract can be placed in a bottle and stored in a freezer until needed. Keep the bottle cap loose, or else the expanding water in it might crack the bottle. Remember to bring the extract to room temperature before performing any work on it.
8. Filter the extract to remove any coarse particles.
9. A *pH* reading is then taken using *pH* paper. If the *pH* is 4.5 or below adjust with sodium hydroxide, or else the agar will not gel.
10. Add 1.5 per cent of agar (3.75 grams and 1 per cent of dextrose (2.5 grams) to the extract.
11. The agar and dextrose are brought into solution by boiling.
12. Dispense the finished extract into test tubes and sterilize at 121° Centigrade for fifteen minutes. Slant tubes, which after cooling, can be inoculated.

The fungi are inoculated onto the slant using the regular mycological procedure. The results are compared with the growth of fungi on Saboraud-Dextrose Agar (control), the most widely-used fungal culture medium. Following inoculation the cultures should be kept in an incubator to insure a constant temperature.

The choice of types of fungi to be utilized is optional. However, the fungi employed in this experiment included representatives (two) from each of the five groups, as follows:

Yeasts: Nematospora coryli; and Saccharomyces cerevisiae.
Basidiomycetes: Poria johnsoniana; and Coprinus radians.
Phycomycetes: Rhizopus arrhizus; and Cunninghamella echinulata.
Deuteromycetes: Fusarium solani; and Cephalosporium ciferri.
Ascomycetes: Thielavia terricola; and Fimetaria humana.

The cultures were kept on Petri dishes of Saboraud-Dextrose Agar from which the transfers could be made and stored in an incubator.

Readings were made one, three, seven, and fourteen days following the original transfer as to surface growth in the test tubes as follows:

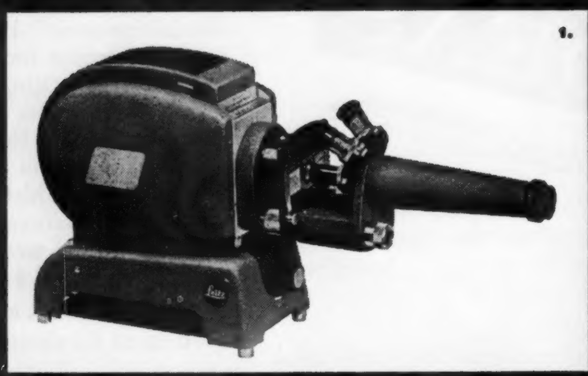
No. X—No growth.
No. 0—Trace of growth.
No. 1—Growth 1-25 per cent of the slant.
No. 2—Growth 26-50 per cent of the slant.
No. 3—Growth 51-75 per cent of the slant.
No. 4—Growth 76-100 per cent of the slant.

Characteristics such as type of colony and pigments produced, if any, were also recorded. Pay particular attention to any inhibitory effect that the medium may exhibit.

Some crude drugs that are easily obtainable, inexpensive, and show interesting results are as follows:

Clove	Black Pepper
Vanilla Bean	White Mustard Seed
Allspice	Poppy Seed
Rosin	Spearmint Leaves
Caraway Seed	Celery Seed
Peppermint Leaves	Sage
Anise Seed	Bay Leaves

Not only does this project afford the student with a valuable experience in biology, but also shows him what a project in research is actually like. This particular area of biology is neglected and passed over by many scientists. Too many high school students are under false impressions that research is characterized by spontaneous discoveries, one after another. This problem-solving experience presents present-day research—with its routines and relatively small discoveries, adding small colors, little by little, to fill the entire canvas of the painting as a whole.



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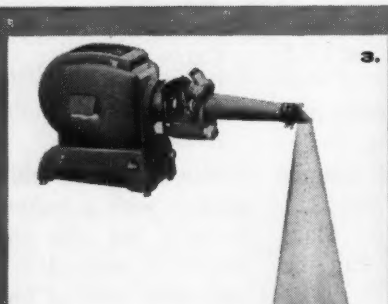

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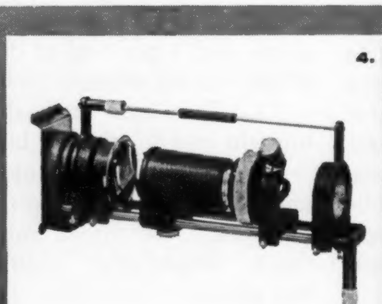

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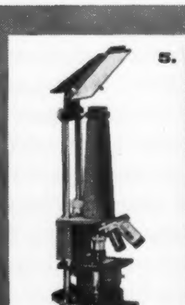

5.

Protein Structure

By JOHN N. ARONSON, Arizona State University, Tempe, Arizona

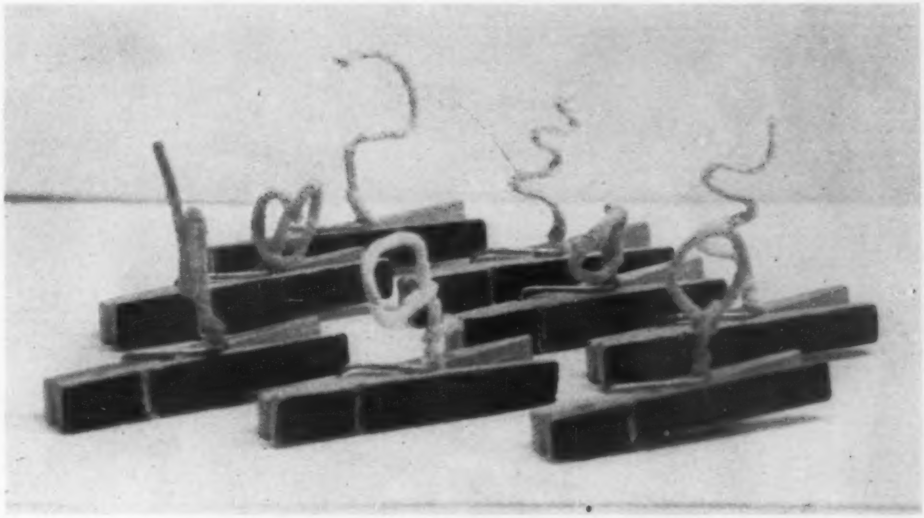

FIGURE 1. Representation of individual amino acids.

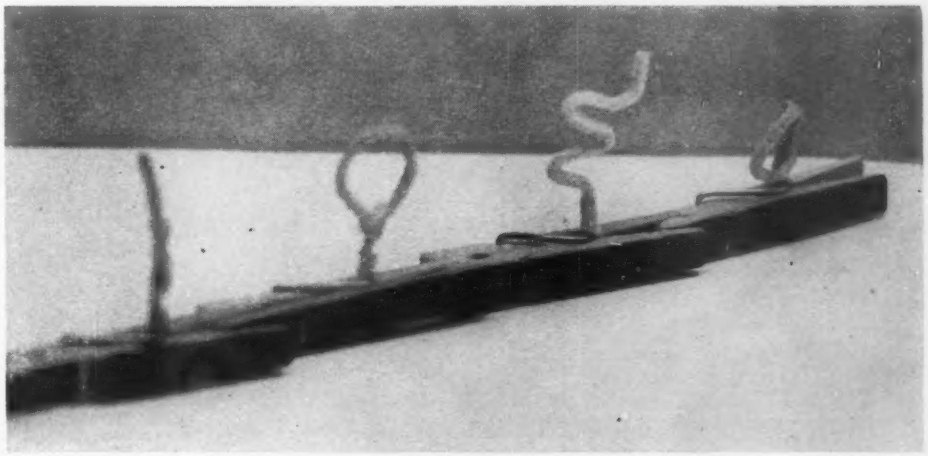

FIGURE 2. Some "amino acids" linked to form a tetrapeptide.

FIGURE 3. A "polypeptide" coiled to form an alpha helix.

The natural abundance of proteins and the wide range of biological functions in which they participate enable the proteins to be one type of complex material that lends itself to a nontechnical discussion. The chemical structure of proteins can present an insurmountable barrier, however, to people whose background in chemistry consists of no more than a brief understanding of atoms, elements, and the combination of elements to form molecules or compounds. Through the use of some clothespins and pipe cleaners, however, the chemistry of proteins has been presented to a selected group of fifteen youngsters representing grades 5 through 8.[1] Their acceptance of the presentation and their comprehension of the material were evidenced by the pertinent questions which they asked at the end of the discussion.

At first, the students were told that proteins could be broken down completely to the elements carbon, hydrogen, nitrogen, oxygen, and a lesser amount of sulfur; but one could just partially break the protein down into "building blocks." These "building blocks" are small molecules known as amino acids, so-called because they all have an acid group and an amino group. All amino acids contain carbon, hydrogen, oxygen, and nitrogen, and a few contain sulfur. The amino acids can be represented by an ordinary spring-type clothespin, the acid group being represented by the head (biting end) of the clothespin, the amino group by the tail. Over twenty different amino acids can be found in proteins; all have the same head and tail, but they differ from each other by variations in side groups which are represented by colored pipe cleaners which are bent in varying shapes and attached to the middle of each clothespin (Figure 1). It is explained that amino acids fall in five general groups which thus are

[1] The students were selected by their teachers at Payne Training School, Arizona State University, on the basis of their aptitude and interest to attend an experimental class on the Nature of Science conducted by Dr. Theodore Munch in the Department of Physical Sciences, Arizona State University.


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represented by five colors of the pipe cleaners (white for aliphatic, red for acidic, blue for basic, yellow for sulfur-containing, and green for aromatic). (The pipe cleaners can be easily dyed with food coloring, water colors, or more permanent cloth dyes.) The side groups within each color group have similar chemical properties, but their size and shape can differ. This can be shown by having the pipe cleaners foreshortened and/or bent in any of numerous patterns.

The amino acids can join together by the head of one clothespin "biting" the tail of a second. The head of the second amino acid is free to "bite" the tail of a third, and so on (Figure 2). Despite the fact that the normal bond angles have been distorted to 180°, configuration can be implied by painting the top and one side of each clothespin black and emphasizing to the audience that the side groups are all found on the same side, with a hydrogen atom on the other side.

An average protein may have a hundred to several thousand amino acids linked together in such a manner. This can allow the existence of literally thousands of different proteins which can be shown by analogy to the number of words in an English dictionary, all derived from various combinations of twenty-six different symbols. For the very young, an analogy to the letters *a, r,* and *t* is suitable since the letters can be combined to form art, tar, or rat, words easily discernible as representing completely different entities derived from the same three letters.

The clothespins can be used to illustrate the helical nature of some proteins. With a little dexterity one can demonstrate the ability of the linear array of amino acids to coil around (Figure 3).[2] It can then be pointed out that side groups which were seemingly far removed from each other may actually be quite close. The importance of the proximity of certain side chains can be illustrated by the suspected active site of the polypeptide hormone angiotensin.[3] Interaction of side groups can be demonstrated with the formation of dissulfide loops, represented by bending two identical yellow pipe cleaners in such a way as to have them touch on the outside of the helix.

The over-simplifications involved in this type of discussion can be offset by the amount of factual material one is able to present with this technique. Variations to the above presentation can be easily made to enhance any value it may have in aiding in the explanation of a complex chemical entity to those whose knowledge of chemistry is limited.

[2] It is even possible to approximate the 3.7 amino acid residues per turn of the helix proposed by L. Pauling, R. B. Corey, and H. R. Branson, *Proceedings of the National Academy of Sciences,* 37:205. 1951. The tendency for the "peptide chains" to fall apart during handling can be circumvented by placing a nail through the "tail" of each clothespin so that it protrudes only a few millimeters above the surface, but can easily fit into a corresponding hole drilled into the "head" of the next clothespin.

[3] "Chemical Make-Up Steers Angiotensin Activity." *Chemical and Engineering News,* 38:45. November 21, 1960.

Chemistry

Visual Aid for Teaching Electron Configuration

By ALFRED L. MILLER, Rock Hill Academy, Charlottesville, Virginia and ERTLE THOMPSON, University of Virginia, Charlottesville, Virginia

The purpose of this paper is to share an experience which the author has found useful in visualizing and helping others to understand a basic concept in modern chemistry. This model illustrated, like any teaching aid for high school courses, will not serve all the needs of teachers, but has more than one application.

There is a trend to use the chemical bond and/or atomic and molecular structure in teaching chemistry in the high school. For this purpose the configuration model was made. The high school student of today has become audio-visually conditioned to the point that he can envision a concept more from a real and concrete example than one which is abstract.

Let us consider the model used. The purpose of the board is to show:

1. Electron configuration.
   a. Electron pairing
   b. Energy levels
      (1). Main levels
      (2). Sub-levels
2. Maximum number of electrons in each level.
3. Order of filling levels.
4. Isotope structure.
5. Ground state versus activated state.
   a. Balmer series
   b. Lyman series
6. Explanation and correlation of quantum numbers.

For an understanding of how the model can accomplish these purposes, perhaps a discussion of its construction will be of value (Figure 1).

First, a series of circles are drawn so the second circle is a basic unit (say one inch) from the first, the third circle is two units from the second, the fourth circle three units from the third, etc.

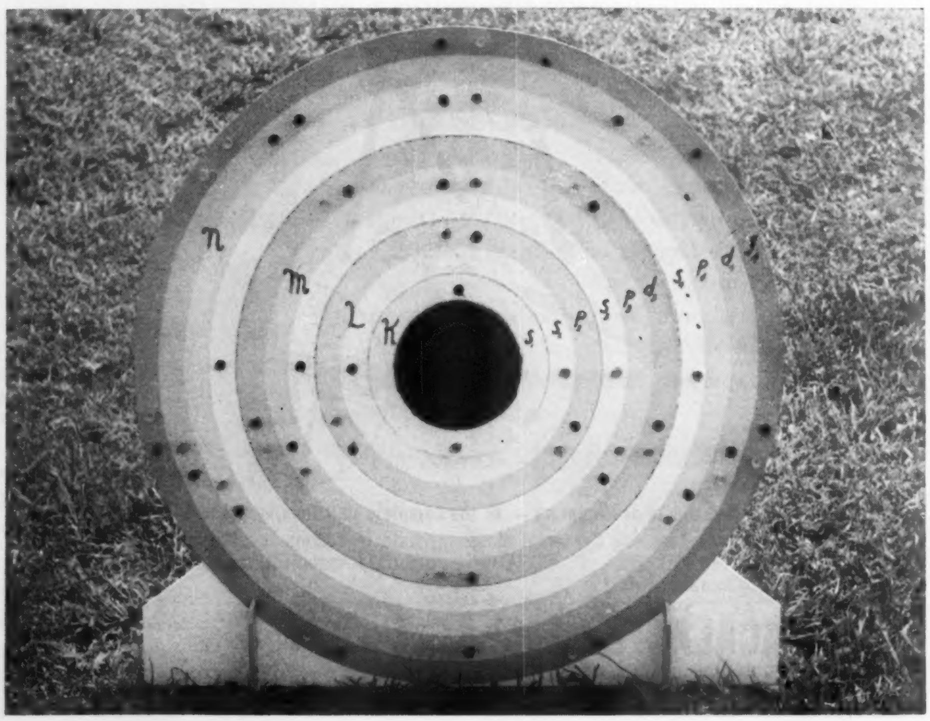
If we designate the central disc as the nucleus, we are now able to further designate each of the rings as the K, L, M, or N main energy levels, starting with the innermost and proceeding toward the periphery. We can assign also to these rings a value for the principle quantum number *n*. Thus *n* for the K level becomes 1, *n* for L is 2, *n* for M is 3, etc.

Each of these rings is further divided such that the second ring has two parts, each the width of the first ring, the third ring having three parts each the width of the first, etc. These "inner rings" are the subshell levels and are labeled 1s, 2s, 2p, 3s, 3p, 3d, 4s, 4p, 4d, and 4f. By selecting a color such as blue and making four shades, each a bit darker than the preceding, we have a way of differentiating the subshells. All of the *s*'s are painted the lightest shade, the *p*'s a shade darker, the *d*'s darker yet, and the *f*'s the darkest shade. This scheme gives four concentric rings of light-to-dark shades of color. The inner disc is painted with liquid slate such that proton and neutron count or atomic numbers or mass numbers can be written upon it.

At this point, each of the major rings should be cut out by means of a saber saw. Pins are then inserted to achieve a gimbal arrangement and a three-dimensional effect. Holes should now be drilled, geometrically balanced for visual effect, representing the number of electrons that can occupy each particular subshell. The holes should be large enough to accommodate golf tees used to represent electrons. These are of two colors and have similarly colored marbles glued to their heads. The two colors used are to differentiate right-hand spin from left-hand spin.

The following should help the reader understand how a periodic table of the elements can be developed by the successive addition of electrons as governed by the atomic number. One peg in the first ring is labeled $1s^1$ to show that it is in the first (Bohr) orbit or main energy level. The *s* denotes the subshell, and the exponential *1* shows that it is the first electron to occupy this subshell. This first element is, of course, *Hydrogen*. For the next element (Helium) we add a peg (of opposite color) designated as $1s^2$ where the principle quantum number $n = 1$ again denotes the first orbit, *s* denotes the subshell (or orbital) and the exponential *2* shows that it is the second electron to occupy this sub-level. This completes the orbit and also the first period. The next element, Lithium, would be designated $1s^2$, $2s^1$ showing that the electron is now filling the second orbit in the *s* orbital. This process continues until we reach Neon which has an "orbital address" of $1s^2$, $2s^2$, $2p^6$. At this point we have completed the second principal quantum number, as we have eight electrons contained in it. This is the full complement of this particular quantum number. We can see

FIGURE 1. Basic construction of models (without spectral lines).



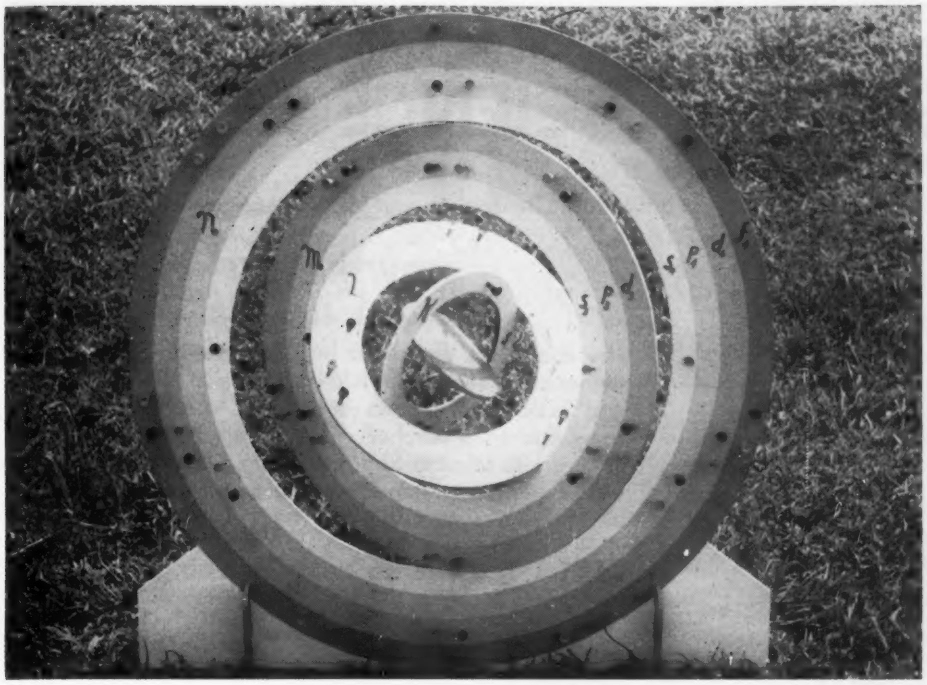


FIGURE 2. Three-dimensional effect of model.

also that there are normally ten electrons associated with Neon, and that both the K and L shells are full.

The third period of elements starting with Sodium, $3s^1$ and ending with Argon $3s^2$, $3p^6$ (showing only electron distribution for the third or M level) has the 3d sub-level vacant.

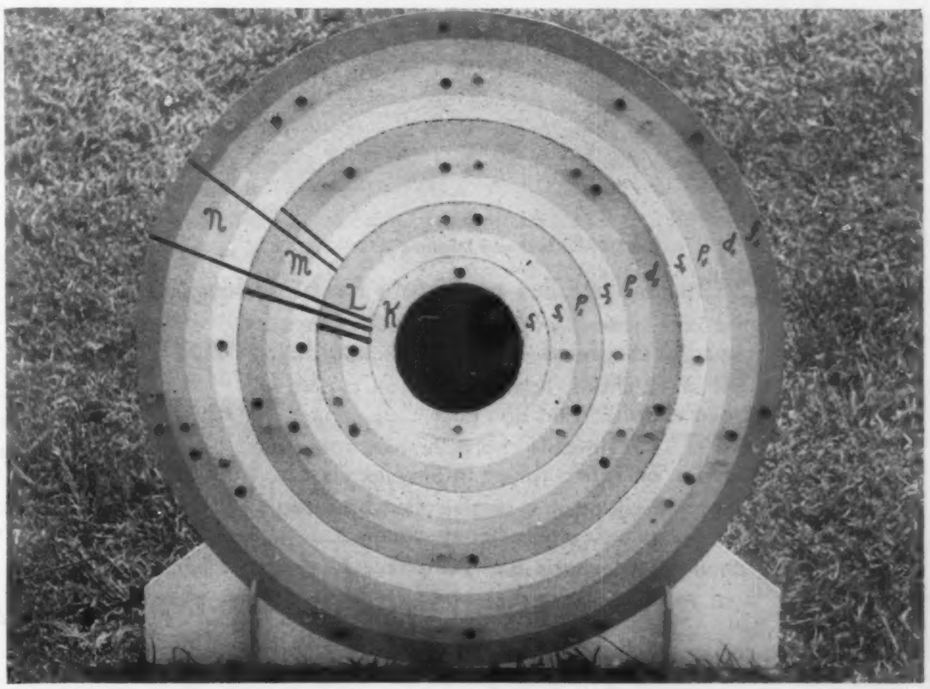
If we begin to develop the fourth horizontal row, we can see one of the advantages of this visual model. Potassium (atomic number of 19) has its nineteenth electron in the 4s level, not in the 3d level. Further, Calcium, whose atomic number is 20, has its last two electrons in this 4s sub-level. Scandium, the next element (atomic number of 21) has the "orbital address" $4s^2$, $3d^1$. From here to Zinc, where the 3d level is full—$4s^2$, $3d^{10}$, the filling of the sub-level proceeds in a normal manner. Since the lowest energy levels are filled first, we can conclude that the 4s sub-level must be lower than the 3d sub-level, or in other words, the third and fourth shells must overlap. Another conclusion that can be drawn at this point is that each sub-level has a definite number of electrons associated with it, namely two electrons (one pair) in the *s* sub-level, six electrons (three pairs) for the *p* sub-level, ten electrons (five pairs) for the *d* sub-level, and fourteen electrons (seven pairs) in the *f* sub-level. A little imagination will suggest many other possibilities for use of this model. (Figure 2.)

One more feature that can be seen are the Balmer and Lyman series which are painted on the model in invisible "black light" paint. (Figure 3.) The black lines represent the energy absorbed by electrons as they move to higher energy levels. The spectral lines that appear when an electron falls back into a lower energy level are shown when ultraviolet light is focused on the model. An effective substitute is the use of cellophane tape in case invisible ultraviolet paint is not available. Should the permanent spectral lines prove distracting to the reader, wide ribbon could be fastened by tacking to the back of the model and removed when not in use.

The model is not intended to show anything about scale relationships and no effort has been made either to show the relative size of the orbits or their particular shape. [It is to be emphasized that only the *s* electrons follow circular paths; the other electrons follow elliptical paths which this model has not attempted to illustrate but which the teacher can point out. It should also be noted that the directional aspects of electron addition can be illustrated with this model. Finally, while the order of electron addition is not adhered to perfectly in this model, the teacher can make the necessary modifying explanations.]

It is hoped that the idea presented here will give others a spark to make their own apparatus. Perhaps improving on this one as an aid in the presentation of this vital concept of modern chemistry would be a beginning.

FIGURE 3. Model of Balmer and Lyman spectral lines.



Elections Committee

It is the responsibility of the Elections Committee to prepare a slate of nominees, including at least two persons for each office to be filled on the NSTA Board of Directors. If the Elections Committee is to do its work well, it must have a list of qualified persons from which to select those who will be nominated.

In the elections of 1962, the offices to be filled are those of president-elect, secretary, and directors for Regions II, IV, VI, and VIII. *Each member of NSTA is invited and urged to suggest persons capable of filling these offices with distinction.* In order that the Elections Committee may have comparable and pertinent data about potential nominees, a form has been prepared on which to make suggestions. Copies of this form may be obtained from the Chairman of the Elections Committee, or from the Executive Secretary of NSTA.

Chairman of the 1962 Elections Committee is Ralph E. Keirstead, State Department of Education, P. O. Box 2219, Hartford, Connecticut. Other members of the committee are James V. DeRose, Marple-Newtown Senior High School, Newtown Square, Pennsylvania; Archie L. Lacey, Hunter College, New York City; Alfred J. Schutte, Herricks Senior High School, New Hyde Park, New York; Julius Schwartz, Board of Education, New York City; Sister M. Gabrielle, Holy Trinity High School, Hartford, Connecticut; Dorothy W. Sullivan, Public Schools, East Orange, New Jersey; and Louise O. C. Swenson, Masconomet Regional High School, Boxford, Massachusetts.

Forms suggesting potential nominees should be sent to the Chairman of the Elections Committee as early as possible, but not later than November 1, 1961.

Budget for 1961-62

As a result of the 18th annual business meeting of the NSTA Board of Directors held in Washington, D. C., July 7-9, the following budget for 1961-62 was adopted. This encompasses the basic program of NSTA services and activities plus certain approved projects to be done under contract or special grants. It is noteworthy that $691,200 (total this year) represents a 23 per cent increase over the 1960-61 total of $560,000; also, that projected income from dues and subscriptions amounts to 31 per cent of the basic budget or 22 per cent of the total. Each of the budget items is, of course, comprised of a number of smaller components. A detailed breakdown of the budget is available to NSTA members on request to the Executive Secretary.

A. Anticipated Revenue

1. Memberships and subscriptions	$152,000
2. Regional meetings and national convention	75,000
3. Advertising, Packets, Mailings	143,000
4. Publication sales	33,000
5. Contributions and service charges	91,500
Total	$494,500

B. Basic Program

11. FSA school science clubs	$ 13,000
12. FSA awards for students	18,000
13. FSA "Vistas of Science" books	20,000
14. Periodical publications	84,000
15. Sales publications	12,000
16. Packet and mailing services	40,000
17. Regional meetings and national convention	53,000
18. Committees, affiliates, field services	15,500
19. Board and staff	172,000*
20. Operational and promotion	52,000
21. Contingencies or reserve	15,000
Total	$494,500

* This cost is partially generated by the projects listed in C and is partially covered by the difference in gross and net totals in C entered as part of A-5.

C. Supported Projects

Gross Grants (including service charges)	$167,200
Balance on deposit	47,000
Gross total	$214,200
31. NCI film project	$ 74,700
32. IBM teaching materials project	33,500
33. International youth science study tour	6,500
34. "Century 21" exposition	40,500
35. Science teaching facilities study	10,000
36. Elementary science studies	3,500
37. U. S. registry of science teachers	28,000
Net total	$196,700
Difference (service charges)	$17,500**

** Difference between net and gross totals included as part of sum entered as A-5.

Regional Conferences, 1961

Northeastern Regional Meeting

Boston is the site of the seventh in the 1961 series of Regional Conferences of the National Science Teachers Association. The meeting will be held October 6 and 7. All exhibits, sessions, and other scheduled activities will be housed at the Hotel Bradford, 275 Tremont Street. While the conference will serve chiefly the science teachers of New England, those interested from elsewhere are most welcome.

"Learning Science for the Space Age" is the conference theme, and the program will focus on the means for helping young people learn science in an effective and efficient manner. In addition, an effort will be made to look to the future in keeping with the rapid expansion and extension of science now taking place.

The Conference begins formally October 6, but registration will open at 4 p.m., Thursday, October 5, and continue until the close of the meeting. Exhibits of apparatus, materials, and books may be viewed Thursday afternoon, and a number of science teaching films will be shown in the early evening. Also on Thursday evening will be a session for heads of departments, consultants, and others with supervisory responsibilities in science. A social mixer is scheduled later that evening and will include opportunities to renew acquaintances.

The first of the three major addresses to be delivered will review our best knowledge of how learning takes place and will relate the significance of such knowledge to the learning of science. This address will be given at the first general meeting at 10 a.m., on October 6. At a banquet session that evening, the second major address will be given. The topic relates to scientific enterprise as a unique kind of human activity.

The afternoon of October 6 and the morning of October 7 will be devoted to concurrent sessions on a wide variety of specific topics dealing with the curriculum and instruction in science. There will be a number of other sessions for each level

of instruction: elementary school, junior high school, and senior high school. The concluding general session will be a luncheon meeting at 1:00 p.m., Saturday, October 7. The final major address, at the luncheon, will present a look ahead by an eminent scientist in one of the various fields of science.

Registration fee for the conference is $2. Housing accommodations at the Hotel Bradford are available from $7.50 up for a single room, and $11 up for a double. For a conference program or further information write to *Co-chairman*, Jesse O. Richardson, State Department of Education, 200 Newbury Street, Boston 16, Massachusetts.

Northwest Regional Conference

The eighth NSTA Regional Conference will be held in Portland, Oregon, Friday and Saturday, October 13-14, 1961, in the Sheraton Hotel. The conference theme is "The Key to the Cosmos" and will emphasize learning science as an individual experience. Science teachers from Alaska, British Columbia, Idaho, Oregon, and Washington are invited, as well as others who can arrange to attend.

Considerable attention has been given recently to the role of teachers and materials in the educational process. Their importance cannot be denied; yet they are ineffectual unless keyed to the most important factor in the classroom, *i.e.*, the learner and how he learns. To this end, the Northwest Regional Conference will devote its energies.

Registration will open at 8:30 a.m. on Friday, October 13. The keynote address, "The Importance of Learning Science," will give attention to the need for a science-literate populace in the world of today and tomorrow. The second session on Friday morning will be devoted to youth activities of NSTA and how these efforts may make contributions to the total educational process.

The early part of Friday afternoon is reserved for committee and group meetings. These meetings will be followed at 4:00 p.m. with a general session which will consider "The Process of Learning Science." This session will be concerned with the ways in which children, and in fact, all who study science, can acquire an appreciation for and an understanding of science most effectively.

The conference banquet will be held on Friday evening in the Sheraton Hotel Ballroom. The banquet program will be directed toward "The Frontiers of Science."

The Saturday program will open with a symposium on "Science Education Tommorrow" which will bring together the thinking of those involved in major curriculum revision efforts at the elementary and secondary levels. The symposium will be followed by concurrent sessions which will consider specific programs such as BSCS biology, CHEM Study and CBA chemistry, PSSC physics, new curricular designs for physical science, and recent developments in the elementary science curriculum.

The Saturday conference luncheon will be held in the Sheraton Ballroom and will feature an address on "The Nature of Enquiry." Concurrent sessions will follow the luncheon and will be devoted to "Curbstone Clinics" in separate meetings for teachers of elementary, general and physical science, biology, chemistry, and physics. The "Clinics" will consider a variety of specific problems of teaching.

Housing is available at the Sheraton Hotel. For information and reservations, write to Harold Trautman, *Co-chairman*, Northwest Regional Conference, 631 N. E. Clackamas Street, Portland 8, Oregon.

North Central Regional Conference

"Motivating the Learner" is the theme of the ninth NSTA Regional Conference of 1961 to be held at the Netherland Hilton Hotel, Cincinnati, Ohio, on October 20-21, 1961. Science teachers, supervisors, administrators, and educators

from Michigan, Western Pennsylvania, West Virginia, Ohio, Kentucky, Indiana, and Ontario, Canada, as well as from other states, are invited to participate. Attention will focus on the learner and the conference program includes challenging sessions for science teachers at the elementary, secondary, and college levels to explore fully.

Science teachers attending the conference may register starting at 4:00 p.m., Thursday, October 19 and through Saturday noon, October 21. A hospitality hour is planned for Thursday evening for "early bird" arrivals. Commercial and educational displays representing at least 35 exhibitors will be set up on Thursday and open through Saturday. Film previews in elementary science, biology, chemistry, physics, and general science are scheduled for late Friday afternoon.

Dr. William M. Alexander, Chairman of the Department of Education, George Peabody College for Teachers, Nashville, Tennessee, will be the keynote speaker at the opening session on Friday morning. Dr. Alexander will address his remarks to the "Nature and Needs of the Learner in the 1960's." Discussion groups will follow. Friday afternoon sessions will be concerned with motivating the less able, the able and average pupil at the junior and senior high school levels; the elementary teacher will have a choice of several small discussion groups dealing with Earth Science, Living Things, and Matter-Energy. The college group will center their attention on teacher education in science.

Luncheon speakers and their meeting topics follow: Friday, October 20, "Secondary Science Education in the 1960's," by Herbert A. Smith, Professor of Education, University of Kansas, Lawrence; and Saturday, "Elementary Science Education in the 1960's," by Willard J. Jacobson, Professor of Natural Sciences, Teachers College, Columbia University, New York City.

The Friday evening schedule includes an address by a nationally prominent scientist on a topic related to space science.

At the general session on Saturday morning, John Slaymaker, Professor of Education, Wittenberg College, Springfield, Ohio, will discuss, "The Motivation of the Gifted." Following the general session, "Here's How I Do It" sessions will be held in six groups for primary and intermediate teachers; secondary groups will discuss such national course content studies as the PSSC, CHEM, and BSCS. A fourth group will discuss trends in junior high school science instruction, and another group will cover areas of the NDEA program.

Following the luncheon on Saturday noon, intermediate and primary discussion groups will meet to discuss aspects of Dr. Jacobson's address; the topic for two panels being planned as part of the elementary program for Saturday afternoon is "Building a Science Program." "Here's How I Do It" sessions are planned in physics, chemistry, biology, general science, and earth-space science.

For additional information, write Kenneth E. Vordenberg, *Chairman*, Cincinnati Public Schools, 608 East McMillan Street, Cincinnati 6, Ohio.

NSTA Staff

The Association welcomes additional new staff members who reported to NSTA headquarters this year.

Elementary Science

Frank R. Salamon, in the position of *Specialist in Elementary Science* will assist in professional and related activities in the many areas of elementary science. He also assumes the responsibility of *Editor* of the Elementary School Science Bulletin published by NSTA.

Frank Salamon

Mr. Salamon is a native of Connecticut, was graduated from Central Connecticut State College in 1950, received his Master's Degree in Education from the University of Hartford in 1956, and pursued advanced studies at the universities of Columbia (Teachers College), Harvard, and Colorado, and Northern Michigan College. His teaching career of nine years began in the elementary classrooms of Cherry Brook School, Canton, and the Morley School, West Hartford.

Since 1957 he has been part-time instructor at the University of Hartford while serving full-time as science consultant for the West Hartford Public Schools.

He became a resident in Washington during June, with his wife, the former Dorothy M. Kleinhenn of Lebanon, Ohio, and their two children, Frank (6) and Joan Marie (4).

Youth Activities

During 1961-62, NSTA's FSA program will be in the capable hands of Dorothy Tryon who joined the Headquarters Staff in August as Director of the project.

Dorothy Tryon

Miss Tryon is on leave of absence from her position as head of the science department at Redford High School, Detroit, Michigan. She has been an active NSTA member, and her long record of participation includes two terms as a member of the Board of Directors, and two years of service as Recording Secretary and as member of the Executive Committee. Miss Tryon is well prepared for her new role since she served as a member of the FSA Administrative Committee during the time when NSTA was studying the proposal to develop the FSA program.

Her graduate and undergraduate work was completed at Wayne University where she received a Master's and Bachelor's Degree in Chemistry. She is active also in other science organizations such as the American Association for the Advancement of Science, the American Chemical Society, and the National Education Association.

Mr. William P. Ladson who served as FSA Director for nearly two years has resigned to accept an appointment at the University of Maryland. He will serve as Assistant in the Chemistry Department and pursue graduate studies to obtain the Doctor's Degree.

Miss Virginia Gatti, the new secretary to the publications section, comes to NSTA from Northern New Jersey. She attended Saint Joseph College, Emmitsburg, Maryland and The Washington School for Secretaries, Washington, D. C. This appointment marks the beginning of her career in the publications field.

In the office of the Associate Executive Secretary of NSTA is Mrs. Esther Patterson, a native of the Pittsburgh, Pennsylvania area. Her experience includes over fifteen years of secretarial activities.

FSA Chapters

The Future Scientists of America school science club moves into its second year of operation coincident with the opening of schools for 1961-62. The progress of this youth movement during the past year was amazing as nearly 800 FSA Chapters were installed with a total membership of some 25,000 junior and senior high school students. These figures are expected to double or triple in the year ahead.

Enrollment of FSA Chapters for 1961-62 is now under way. *Present chapters* have been billed for annual dues and payment should be made before *November 1* in order to receive all services and materials without interruption. School science clubs desiring to affiliate as *new chapters* of FSA should fill out an enrollment form and send it to NSTA headquarters together with the charter fee. Additional information, forms and schedules of fees and dues may be obtained from the Director of FSA.

Materials and services inaugurated last year will continue and new additions will be included for 1961-62, meaning that all FSA chapter sponsors may look forward to receipt of the following:

- One copy of the *FSA Sponsor's Guidebook* (upon initial affiliation).
- Continuing revision service for the guidebook.
- Five copies of each of four issues of *The FSA Centrifuge* for use by sponsors and chapter officers.
- FSA membership cards for student members of the chapter.
- Information about the program of FSA awards for students.
- FSA pins, emblems, and other materials (available at low cost).

As in the past, the total FSA program

will continue under the direct supervision of a Steering Committee and with the critical counsel of a Field Advisory Board comprised of 150 teachers selected from all parts of the U. S.

FSA Awards, 1962

Important changes have been made in the program of Future Scientists of America awards for students for 1961-62. First and of greatest significance to students is an enlargement in the number of regional awards and the addition of twenty-five college scholarships of $250 each for students in grades 11 and 12.

Second is a broadening of the base of support, financial and otherwise. After ten years of solo sponsorship by the American Society for Metals, the FSAA program will henceforth enjoy and benefit from co-sponsorship by several scientific, engineering, and technological societies and trade associations. The ready acceptance of FSAA by these groups is eloquent testimony of the impact of this program and its value in helping to keep the pipelines open for tomorrow's scientists, engineers, and technicians.

In order to provide for the college scholarships, awards of U. S. savings bonds have been dropped. Instead, regional winners in grades 7-12 will receive FSA medallions, bronze for first-time awards, silver for those who have been winners in previous years. Certificates in the names of all winners will be presented to their school heads. The number of awards has been increased to 20 for each of the grade levels 7-8, 9-10, and 11-12 in all eleven regions, making a total of 660 for 1961-62. In addition, approximately 2000 Honorable Mention certificates will be awarded.

Selection of recipients of the twenty-five ($250 each) scholarships will be made on a national basis by a committee to be set up in Washington, D. C. All regional winners in grades 11-12 will be eligible for consideration. The scholarships will be paid directly to the colleges chosen by the recipients upon evidence of acceptance and enrollment. By turning up as a scholarship winner in both grade 11 and grade 12, it is possible for a student to receive $500 from the FSAA program toward his college expenses.

Information and entry materials for FSAA 1962 are now available from NSTA headquarters. Do not delay in offering your students (the brightest, most strongly motivated 10 per cent or so) this opportunity for encouragement, recognition, and scholarships. *All entries must consist of written reports of research-type investigations or projects.* These may relate to any field of science, engineering, or mathematics. Hence, it is urgent to get started promptly. Closing date for the mailing of reports is *March 31, 1962.*

Co-sponsors of the 1961-62 program of Future Scientists of America Awards for students include the following:

American Cancer Society
American Chemical Society
American Dental Association
American Meteorological Society
American Nuclear Society
American Petroleum Institute
American Society for Metals
National Association of Corrosion Engineers
Society for Non-Destructive Testing
Society of Naval Architects and Marine Engineers

Vistas of Science

The "Vistas of Science" program is rolling with fourteen books in various stages of production. (See February 1961 *TST.*) The first three books are scheduled for release during the fall of the 1961-62 academic year. Five more are planned for publication during the remainder of the year. Each book is supported by a grant from government, business, foundations, or professional organizations. Preparation of each book is initiated by a planning conference composed of the primary (or text) author, the author of the student activities section, and an advisory committee

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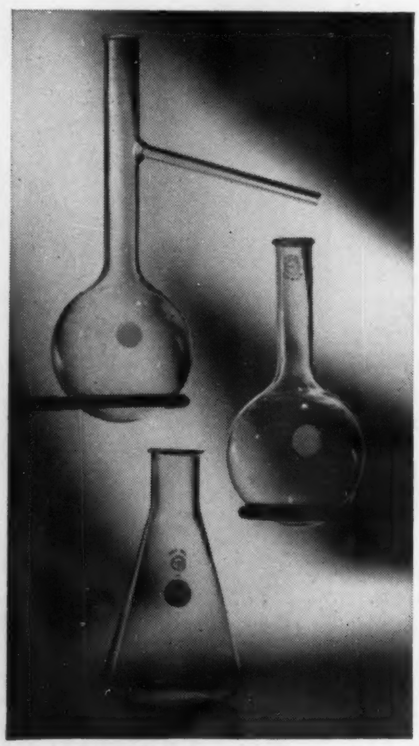
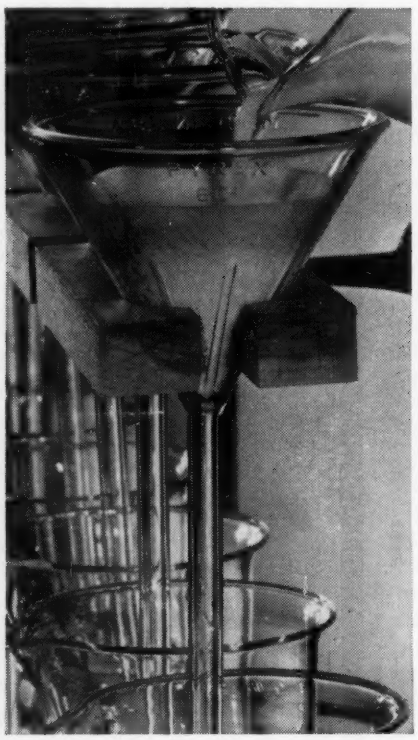
Machine-made beakers. Each one with walls as heavy and uniform as every other—for maximum strength. For a few pennies more than the cost of the standard No. 1000 beaker, you can get the new No. 1002 with white enamel approximate graduations.

Our No. 1552 reagent bottles make good reading. They're smartly labeled front and back in permanent green on a white enamel background. Ideal for divided-bench use. The bottles won't cloud, the polyethylene stoppers won't stick.

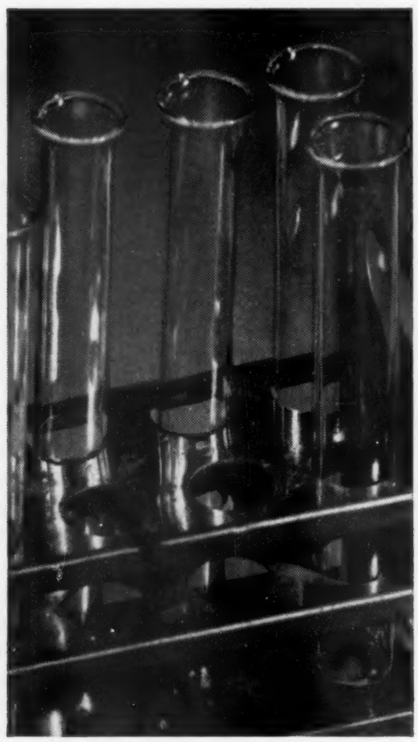
The No. 3075 cylinder is designed for students. Its detachable hexagonal plastic base won't break, discourages the cylinder from tipping and rolling. Cylinder top and spout are heavily reinforced. Sharp, white graduations.



Flasks must take knocks and bangs, quick heating and quick cooling. PYREX boiling, distilling, and Erlenmeyer flasks provide over-all strength for safety. They're designed to conduct heat quickly and evenly.



Your students get faster, more complete filtration with Nos. 6160, 6180 funnels, because of filtering grooves pressed into the cone wall. Pressed construction also builds strength and makes for an accurate angle for the filter paper.



Machines make our test tubes stronger, especially at top and bottom hazard points. The tubes are reinforced with a bead at the lip to resist chipping. Bottom radii are machine-uniform in strength, dependability, thermal safety.

consisting of a research scientist, a science educator, and a classroom science teacher. Particulars regarding topics and sponsors, authors, and advisory personnel for each of the first books scheduled for release this fall are as follows:

"Cell Physiology," sponsored by the National Cancer Institute. Text and activities author: William Deering, Associate Editor, *Science World*, New York City. Advisory committe: George Woolley, Sloan-Kettering Institute, New York City, research scientist; Robert Gordon, North Shore Schools, Glen Head, New York, science educator; and Carolyn A. Gibson, North Hills High School, Pittsburgh, Pennsylvania, science teacher.

"Spacecraft," sponsored by the National Aeronautics and Space Administration. James V. Bernardo and John Sims represent NASA's education branch. Author: James J. Haggerty, Jr., Aerospace Writers Association, Washington, D. C. Activities author: John H. Woodburn, Walter Johnson High School, Bethesda, Maryland. Advisory committee: John F. Clark, National Aeronautics and Space Administration, Washington, D. C., research scientist; Orval Ulry, University of Maryland, College Park, science educator; John H. Woodburn (also activities author), science teacher.

"Measurement," sponsored by the National Bureau of Standards. Text and activities author: William J. Youden, Sr., National Bureau of Standards, Washington, D. C. Advisory committee: A. T. McPherson, National Bureau of Standards, Washington, D. C., research scientist; J. Stanley Marshall, Florida State University, Tallahassee, science educator; and Dale Gerster, Bladensburg High School, Bladensburg, Maryland, science teacher.

Other "Vistas" books planned are concerned with Dental Research, Computers and Data Processing, Ceramics, Biochemistry, Molecular Biology, Astronomy and Cosmology, Space Biology, Thrust into Space, Space Research Serves Man, Water, and Metallurgy.

The sponsor of every Future Scientists of America chapter will receive a copy of each "Vista" as it is released. Individual copies for students will be available through Scholastic Book Services, the publishers of the series.

Supervisors' Section, NSSA

The initial year of becoming an official NSTA section was a banner one for the National Science Supervisors Association. During the summer of 1961, NSSA sponsored a four-week Science Supervisors Institute at the University of Colorado. The Institute was under the direction of James R. Wailes. It oovered discussion of topics as related to the curriculum studies Biological Sciences Curriculum Study (BSCS), Physical Science Study Committee (PSSC), Chemical Bond Approach Study (CBA), Chemical Education Material Study (CHEMS), the application of benefits under the National Defense Education Act, and the K-12 curriculum. J. Arthur Campbell, Harvey Mudd College, Claremont, California and Robert Keller, University of Minnesota, Duluth, were among the guest lecturers.

Officers elected to serve for 1961-62 are: *President,* Elmer W. McDaid, Director of Exact Sciences, Detroit Public Schools, Detroit Michigan; *President-elect,* Elra L. Palmer, Supervisor of Secondary Schools, Baltimore, Maryland; *Retiring President,* Samuel Schenberg, Director of Sciences, Board of Education of the City of New York, Brooklyn, New York; and *Secretary-Treasurer,* Kenneth E. Vordenberg, Science Supervisor of Secondary Schools, Board of Education, Cincinnati, Ohio. Members-at-large of the Executive Committee are: Howard N. Hubbard, Supervisor of High School Science and Mathematics, Long Beach, California; H. V. Bullock, Consultant in Science Education, State Department of Education, Atlanta, Georgia; and Grace C. Maddux, Elementary Supervisor, Cleveland, Ohio, Public Schools.

ADP Teaching Materials

How do computers and the techniques of data processing aid scientists in their work? How can physical models be translated into mathematical models in order that the data produced by the experiment may be reduced to workable form by the computer? What place is there in the science curriculum for studying the principles of computers and data processing?

These are the questions for which NSTA hopes to produce the answers. The Association recently received a grant from the International Business Machines Corporation to prepare secondary-school materials in the general area of automatic data processing (ADP). On April 14-15, 1961, a committee met at Montclair State College, Upper Montclair, New Jersey, to plan the project. Hugh Allen, Jr., Professor of Physics and Chairman of the Science Division, Montclair State College, is directing the project. Other committee members are: Gates Willard, science teacher, Junior High School, Manhasset, New York; James Downes, Professor of Social Studies, Newark State College, Union, New Jersey; Emma Fantone, Professor of Audio-Visual Education, Montclair State College; Chris Arlis (Mrs.), science teacher, Junior High School, New York City; Paul Clifford, Professor of Mathematics, Montclair State College; and Mahlon Hayden, science teacher, Storrs, Connecticut.

The committee agreed that all materials prepared should reflect the central idea that scientists use computers and data processing techniques as an extension of their senses. The materials should also reflect how data processing techniques make use of the scientific process.

As one phase of the project, another title will be added to the growing roster of "Vistas of Science" books. In addition, a film will be produced which will be based on the "Vista" title. While the "Vista" and the film are being prepared, Dr. Allen will conduct a comprehensive review of the material available to schools in the general area of data processing. The committee will reconvene at a later date to decide on the selection of other materials that are accurate and usable in the classroom.

Century 21 Exposition

In Seattle, Washington, from April through October, 1962, a special attraction of interest to NSTA members will be held. The national event, the "Century 21 Exposition," sponsored by the U. S. Department of Commerce will include an extensive science exhibit. NSTA has been invited to participate in planning a portion of this exhibit. With the approval of the Board of Directors in July, NSTA made plans to develop and supervise work on the assigned project of the Children's Area science exhibits. These exhibits will be completed with the following basic guidelines: (1) be designed for the 9-13 year age group; (2) demonstrate basic laws of science; (3) be designed for active participation by the visitors; (4) be so designed that showing on a fixed schedule will not be required; (5) allow the integration of simple programmed instruction machines, if advisable; (6) contain, in some cases, live animals; and (7) introduce science concepts and pedagogy.

Robert A. Rice, NSTA 1960 President, reported to NSTA headquarters on July 1, 1961 to begin his duties as coordinator of the project. He will continue this work through August after which time he will go to Seattle and remain there until the opening of the Exposition.

In accordance with NSTA operating procedures, a special project committee was assembled to select the experiments and demonstrations to be included in the exhibit. This committee met in Denver in June. Members of the committee are: Norman Abraham, University of Colorado, Boulder; John C. Bailar, Jr., University of Illinois, Urbana; Sam Blanc, and Wilfred Miller, Public Schools, Denver, Colorado; Franklyn Branley, Hayden Planetarium, New York City; Michael Butler, Shady Hill School, Watertown, Massachusetts; Richard Schulz, Public Schools, Cedar Rapids, Iowa; Victor Showalter, The Ohio State University Laboratory School, Columbus; Malcolm Smith, Massachusetts Institute of Technology, Cambridge; Robert Stollberg, San Francisco State College, California; Robert Wickware, State Teachers College, Willimantic, Connecticut; and Harvey White, University of California, Berkeley.

Ira C. Davis

Science teachers, students, and educators share equally in the loss of a great colleague and personal, sincere friend by the untimely death of Ira C. Davis in Madison, Wisconsin on May 8. He is survived by his wife, two sons, and seven grandchildren.

Professor of Science Education at the University of Wisconsin and Chairman of the Science Department of Wisconsin High School (where he also taught science classes from 1917 until his retirement from the University in 1957); Past President and life member of the Central Association of Science and Mathematics Teachers and the National Association for Research in Science Teaching; Chairman of the National Science Committee of the National Education Association; Member of the board of directors of the NSTA; Member of the board of trustees of his alma mater, Ripon College (Wis.); these and other posts too numerous to mention give an indication of his more than 40 years of influential service to science education. His contributions to the teaching of science in K-12 and the teacher preparation programs are found in all parts of the world. Ira Davis was born in Randolph, Wisconsin, May 17, 1886, and after graduating from Ripon College in 1910, went directly into teaching. He has to his credit the publication of numerous articles in professional journals and more than ten textbooks in high school general science.

Students in both high school and college hailed him as one of their greatest teachers, as well as a helpful friend. They were inspired and appreciated his demand for high standards of achievement as well as his concern in their personal and professional progress.

Convention NOTES

GENERAL PROGRAM COMMITTEE NSTA TENTH ANNUAL CONVENTION









CHAIRMAN, Elizabeth A. Simendinger, Uniondale High School, Uniondale, New York; J. Myron Atkin, University of Illinois, Champaign; Brother U. Alfred, F.S.C., St. Mary's College, California; Marjorie Behringer, Alamo Heights Senior High School, San Antonio, Texas; Paul DeH Hurd, Stanford University, California; A. J. McNay (B—I Section), Standard Oil Company of California, San Francisco, California; Eugene Roberts, Polytechnic High School, San Francisco, California; Samuel Schenberg, New York City Board of Education, Brooklyn, New York; and Keith Smith, Board of Education, Los Angeles, California. (Ex officio members J. Darrell Barnard, President, NSTA; and Robert H. Carleton, Executive Secretary, NSTA; not shown.)

In the San Francisco Convention—more than in any previous convention of NSTA—every attendant will be an active participant in a critical analysis of issues, problems, and possible solutions in five major areas of concern confronting science education today. These areas of concern are: (1) Curriculum (including areas such as Biology, Junior High School Science, Elementary Science, etc.); (2) Staffing (Elementary Science, Teacher Assistants, Certification, Supervision, Merit, etc.); (3) Programming (Team Teaching, Scheduling, Grouping, Advanced Placement, etc.); (4) Evaluation (Techniques, Studies in Progress, Subject Matter, Achievement Tests, Critical Thinking, Ability Grouping, and Programmed Teaching); and (5) Instructional Materials and Facilities (Teaching Machines, Films, Television, NDEA, Business-Industry Materials, Laboratory Facilities and Equipment, etc.).

The convention design calls for speakers in the general sessions to address themselves to one or another of these areas. As each of these is developed, they will be further considered and analyzed through panel presentations involving national leaders.

Following the panel presentations, discussion groups will be planned with ample time to enable every convention participant to be heard and to contribute his experience and ideas.

Then at the last general session of the convention, all of these funneling-out processes will be re-assembled through a Resolutions Committee that will have been at work throughout the convention. Thus in the final general session, the 2000 or more science teachers on hand can develop a consensus on recommendations and resolutions to be presented for consideration by the NSTA Board of Directors and by other science teaching organizations. It is hoped that this will help in the development of a position or stand by the profession in the decade ahead.

A revision of the "Here's How I Do It" idea has been scheduled by the San Francisco committee. This will consist of an exhibit of devices and apparatus designed by teachers for use in laboratory and demonstration teaching. The display will be open at specified times during which the teacher-designers will be on hand to demonstrate and explain.

In conjunction with these two exhibits will be an enlarged curriculum center where courses of study, syllabi, and teaching plans from schools and school systems may be examined. Curriculum consultants will be available also to confer with those who have problems they would like to discuss.

The two exhibits, the curriculum center, the usual film showings, and the

Annual Exposition of Science Teaching Materials, as well as all general sessions, will be located in the convention auditorium at the San Francisco Civic Center.

Many of the smaller group meetings will be held in hotels and other facilities in the vicinity of Union Square. Located right at the Square are the headquarters hotels, the St. Francis and the Sir Francis Drake. To accommodate the anticipated attendance of 3000, guest rooms have been contracted for in several other hotels and motels in San Francisco. All housing will be handled through the Visitors and Convention Bureau. *Watch for the December issue of TST, which will contain forms for making hotel reservations and for advance registration, including all functions.*

Other innovations in the 1962 convention will include a special meeting session for future science teachers now enrolled in colleges and universities, and a program arranged by and for Future Scientists of America members in the Bay Area. Also, "A Night in Chinatown" is being arranged by the SF Business-Industry Section members with cooperation of the Chinese Chamber of Commerce. This activity will include an authentic Chinese dinner, a walking tour of the area, and an hour and a half presentation of truly authentic Oriental culture and the performing arts. The annual banquet will be held on Sunday evening prior to the visit to Chinatown.

Reminders

All members of NSTA are reminded of these facts about the San Francisco Convention: (1) dates of the convention are March 9 through March 14; (2) if you wish to volunteer as a leader in one of the forty or more discussion groups, write to NSTA headquarters *not later than October 20* and give full particulars including your choice of one area of concern; (3) the annual meetings of the National Science Supervisors Association and the Association for the Education of Teachers in Science will be held in conjunction with the convention; (4) watch *TST* for further announcements.

Chairman of the general planning committee for the San Francisco Convention is Elizabeth A. Simendinger, chairman of the science department, Uniondale High School, Uniondale, Long Island, New York. Eugene Roberts, head of the science department, Polytechnic High School, San Francisco, is coordinator of local arrangements. Other members of the committee are identified along with their pictures on page 61.

Meeting and working with the committee also are NSTA President J. Darrell Barnard and Executive Secretary Robert H. Carleton.

• • • John Hay Fellowships • • •

Seventy-five John Hay Fellowships for 1962-63 will be awarded to public senior high school teachers for a year of advanced study in the humanities at one of the following universities: California, Chicago, Columbia, Harvard, Northwestern, and Yale. During the fellowship year, awards will be equal to school salaries and pay travel expenses for the Fellow and primary dependents, tuition, and health fee. Application will be accepted from candidates in Arizona, California, Colorado, Connecticut, Florida, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Missouri, Nebraska, New Hampshire, New Jersey, New York, Ohio, Oregon, Pennsylvania, Rhode Island, Utah, Vermont, Virginia, Wisconsin, and the District of Columbia. Applications close *December 1, 1961.* Write to Charles R. Keller, Director, John Hay Fellows Program, 9 Rockefeller Plaza, New York 20, N. Y.

Physics and Chemistry—A Unified Approach. Book I. John C. Hogg, Charles L. Bickel, and Elbert P. Little. 374p. $4.96. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J.

This unified approach to the subjects of physics and chemistry is one which is possibly overdue, but is also one that is extremely worth the effort. The authors have shown great initiative and imagination in the method of their approach. Thus they begin by discussing method of measurement and the concepts of energy, work, and power. Consideration is then followed of the electrical nature of matter and thence to the general properties of atoms and of the electrical nature of the forces that bind atoms together in molecules.

The subject then unfolds naturally into a consideration of the simplest of atoms, that of hydrogen, and thence to valence and oxidation numbers and the properties of oxygen and water. Attention is then given to, among other subjects, the atomic theory, weight calculations in chemical reactions, the kinetic theory of gases, heat and temperature, the liquefaction of gases, heat energy in chemical reactions, and Newton's laws of motion.

The form of development of the subject is thus excellent and deserves high praise. The subject matter, however, leaves much to be desired and the text has a number of errors and also what might be considered to be lapses in logic in the detailed presentation. This is therefore a book which can be highly recommended to teachers for guidance in their courses, but it should be given the benefit of quite drastic revision before it could safely be given to students.

It is, therefore, hoped that this excellently conceived book, which will certainly place on a rational basis our approach to the teaching of physics and chemistry, may soon appear in a revised second edition. In the meantime, it can still have a profound and beneficial influence on the formulation of science curricula and should certainly be of interest to all teachers who believe in matching their teaching with the spectacular advances of the physical sciences in the last three decades.

The authors are to be congratulated on this exciting experiment and should receive every encouragement to press it through to a successful conclusion. We shall also look forward with keen anticipation to the publication of Book II.

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The Process of Education. Jerome S. Bruner. 98p. $2.75. Harvard University Press, Cambridge 38, Mass. 1960.

This small volume, barely 98 pages, is too modestly titled. It is *not*, as the title suggests, only a volume on the way teaching and learning take place. Quite the contrary, it is about such matters with a specific emphasis—the new concern for the intellectual in education.

The volume has two significances. In its central concern for the intellectual, it is a sign of the times. The times are calling for a return to "fundamentals" and Bruner here emphasizes the fact that "fundamentals" are not fundamental unless they include the conceptual structures, the ordering principles, which give shape and meaning to the brute facts of experience.

The second significance of this volume lies in what it does with this emphasis on conceptual structure. Very shrewdly, Bruner puts the idea of conceptual structure into a context of learning and teaching as processes. In so doing, he is not only reflecting the times but giving them a nudge in a desirable direction. For by bringing the two together, he provides a bridge for teachers and educators between the immediate past and the probable future of American education.

In the past thirty-odd years, we have habitually treated education as primarily a set of problems for which psychology and the social sciences provided most of the answers. In that older tradition, *"How* shall we teach?" was a question to be answered by psychological and social study of learners and the learning process. *What* to teach was largely decided by appealing to social needs, to individuals' hopes of prosperity and comfort, to political and economic exigencies, as our criteria. And in this way of treating the problems of education, the sources of knowledge—the disciplines of science, history, language, and so on—were largely taken for granted. We tended to assume that they were stable and unchanging bodies of simple and verified facts. Hence, we treated the disciplines merely as reservoirs from which to draw the bits and pieces of knowledge and skill which psychological, social, political, and economic criteria seemed to require as the content of the school curriculum. We rarely treated the disciplines themselves as criteria for deciding what knowledge was of most worth.

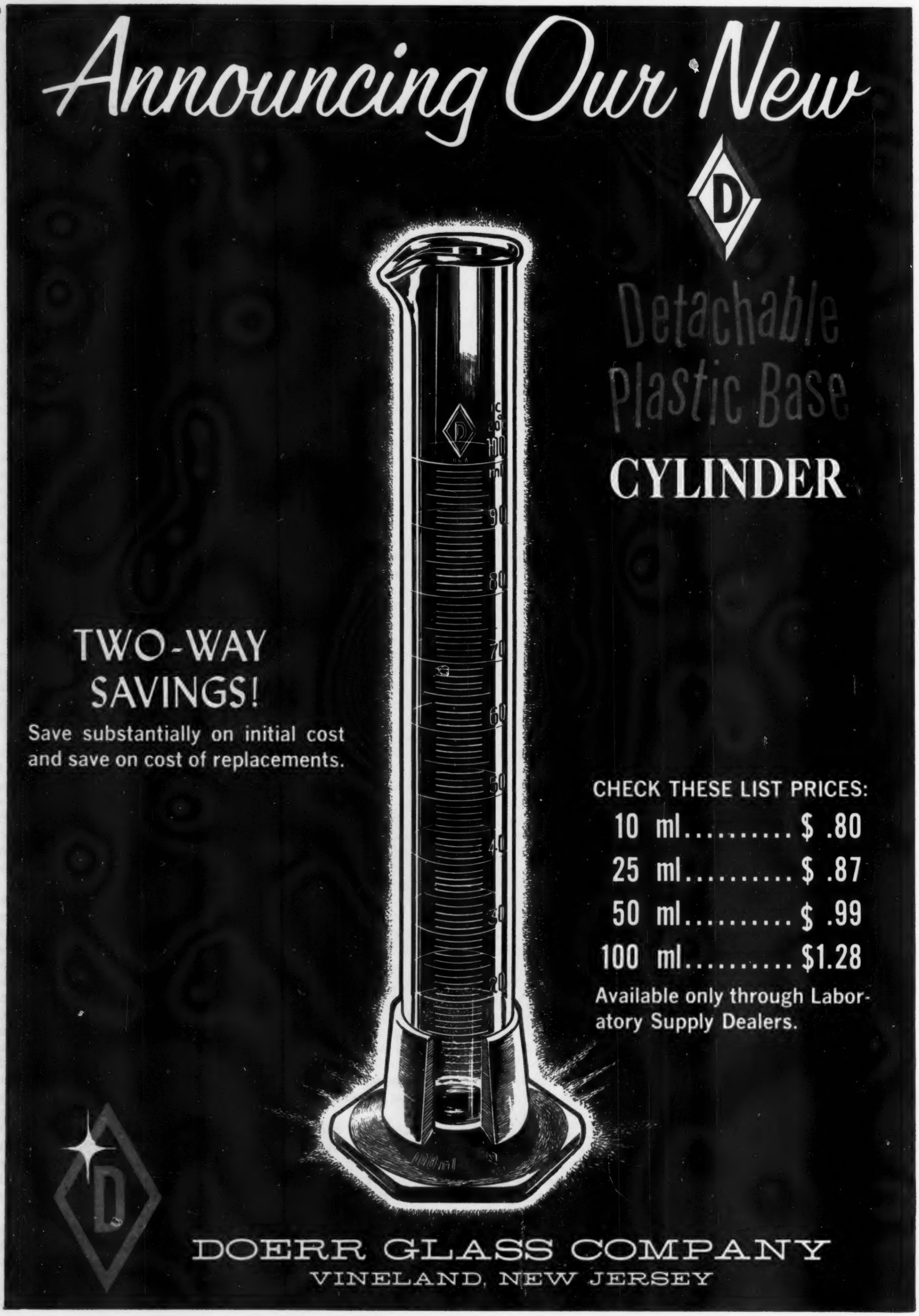
By contrast of these past habits, we currently are faced with a trend toward using the structure and content of the disciplines as the one and only, the *exclusive*, criterion for determining the content of the school curriculum. This trend arises—improperly and unfortunately—because of our tendency in education to work by violent pendulum swings. As if in compensation for past neglect of the disciplines, influences now at work exaggerate the role of the disciplines. For about four decades, the masters and makers of the disciplines largely ignored education and education largely ignored them. Now we are asking for their help and they are giving it. But the long break in communication between scholars and educators is exacting its toll. Both educators and investigators are at a loss for ways of relating their diverse but interconnected concerns—the nature of the disciplines on the one hand, the personal, social, and political responsibilities of education on the other.

In this dilemma, the tendency so far has been to duck the problem of establishing a working relation between the two and, instead, to throw away what was good as well as what was bad in past educational practices in favor of the new—in favor of sole or primary reliance upon the disciplines, upon the judgement of subject-matter specialists.

It is at this point that the Bruner volume makes its most useful contribution. It sketches out one direction in which we can seek for ways to connect the old and the new in education—ways to relate the psychological and social criteria with which we have formerly worked, with disciplinary structure as a further and valuable criterion of what and how to teach.

Specifically, Bruner indicates three relations between the structure of the disciplines and aspects of personal and social need. First, he points out that discipline structure may be the crux of the problem of transfer of "training." If structures are the general plans and patterns which characterize specific items of knowledge and information, then the learning of structures may enormously facilitate the learning and understanding of these specific items. To have learned *one* such item *and* to have learned its underlying pattern or structure should make all other items which rest on the same structure more meaningful and easier to comprehend. In much the same way, structure may contribute to the retention of what is learned. For the structure common to diverse items of knowledge becomes a "code" under which we can file the diverse items for ready recovery.

Second, Bruner emphasizes a possible connection between conceptual structure and originality or "creative thinking." For, on the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one hand, such general structures are intellectual tools which the mind can bring to bear in the solution of new problems. Conversely, the teaching of existing knowledge through re-creation or "discovery" is effective teaching.

Third, Bruner suggests—though largely between the lines—that the experience of understanding general ideas, of discovering and using them in the solving of problems, may provide an important motivation of the young toward learning and the intellectual. For discovery and mastery are themselves rewarding events; they please us by testifying to our competence.

The bridge which Bruner builds between old and new is, as a quick re-examination will reveal, largely a psychological bridge. His major terms—his structure, forsooth!—are largely psychological terms: transfer, understanding, retention, thinking processes, motivation, etc.

In this emphasis on the psychological, other important factors are omitted—the sociological, the economic, and the political. Yet these, too, have significant connections with conceptual structures as components of curriculum. For example, the changing pattern of national leadership, the new ways the lay leaders and specialists communicate, and their interactions in solving our large-scale problems make it imperative that laymen and specialists alike possess a working knowledge of the organizing, conceptual principles of the disciplines. In discussing this point some years ago, I referred to these

principles, indeed, as the modern, functional equivalents of the ancient liberal arts.[1]

Though such political, social, and economic factors are of great importance in education, I have no quarrel with their omission from the Bruner volume. It is a short volume and Bruner is a psychologist. Let the shoemaker stay with his last.

I do quarrel, however, with what happens to the idea of conceptual structure in this volume. In the process of being incorporated into the psychological frame which Bruner uses, the nature of the conceptual structure of the disciplines is vastly oversimplified and curtailed. The impression is conveyed that "structure" refers merely to the more general forms of thought, of which specific items of knowledge are instances: "enzyme," as well as the enzyme, pepsin; "tropism," as well as some particular response of some species of organism to some specific stimulus; "passive voice," as well as, "the man *was bitten*—."

Further, the impression is conveyed that such structures are "givens," that is, *laws* of nature, of language, or of mathematical entities. We have, for example, this statement, "To learn structure, in short, is to learn how things are related." (See page 7.)

What is dangerously obscured by these simplifications and restrictions is that structure is first and foremost a characteristic (not of items of knowledge), but of a *discipline*, of a mode and manner of investigation. It is this conceptual structure of a *discipline* which defines what data are relevant in an investigation and tells us what sense to make of the data, once they are obtained. It is because a given group of investigations are guided by such a conceptual structure that items of knowledge result which have that structure.

To obscure this essentially investigative and instrumental character of structures is to leave us pretty much where science teaching of the past has put us—purveying scientific conclusions as if they were fixed and permanent truths; leaving no secure place in education for clarifying the nature of enquiry and the contingent, tentative character of systematic knowledge.

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The Balance of Nature. Lorus J. and Margery Milne. 330p. $5. Alfred A. Knopf, 501 Madison Ave., New York 22, N. Y. 1960.

There are books covering the subject of ecology which are of interest to and can be understood only by the professional ecologist. Other books are available which purport to discuss ecology which the professional ecologist would not accept because the authors' attempts to simplify frequently lead to misrepresentation of facts. The Milnes have captured the "middle ground." They have written a book which is authoritative and, at the same time, makes for enjoyable reading for the nonprofessional. There is a wonderful sprinkling of philosophy throughout the book. Frequently the reader is led to reexamine his own philosophy concerning the place of man in the scheme of things. For example, the following quote is the last paragraph in the book: "Every living thing also affects man's own evolutionary progress. When any kind of creature disappears, its influence on man goes too. The direction of his development surely changes slightly. Thoreau scoffed at people who believed they 'could kill time without injuring eternity.' By obliterating other kinds of life, man may be destroying himself as well." The authors have accomplished their mission if one uses the title as indicative of content. Numerous fascinating examples of relationships, interrelationships, balance in nature, and lack of balance are included. These range from the effect of importing foreign species as in the case of the mongoose and its control of rats in the West Indies to the effect of the importation of rabbits on the economy of New Zealand and Australia. Consistently, the authors present examples, which are devoid of sentimentality. Not only do the living things of the earth come in for examination, but the authors discuss the physical factors of the environment and their relation to the living things. Recommended to every adult as most interesting reading and the book has a wealth of information for the high school biology teacher also. It would be enjoyable reading for his students.

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[1] "Science & Civil Discourse." *Journal of General Education*, 9:3. April 1956.

SCIENCE TEACHING MATERIALS

Prepared by NSTA Teaching Materials Review Committee

Chairman: Dr. H. Seymour Fowler

The Pennsylvania State University, University Park, Pennsylvania

BOOK BRIEFS

Essentials of Earth History—An Introduction to Historical Geology. William Lee Stokes. 474p. $8.75. Prentice-Hall, Inc., Englewood Cliffs, N. J. 1960.
The author presents a review of what is known and inferred about the history of the earth from its remote beginning to the present time. He offers historical geology as a composite science integrating the findings of astromony, physics, chemistry, and biology, along with the facts of geology. He incorporates up-to-date material on the origin of the universe, the elements and man, and summarizes what is presently being done in the study of the origin of life. The text is designed for anyone needing an introductory course in geology, as well as students majoring in all branches of the science. Includes a glossary of selected terms.

Modern Physics. M. S. Smith. 254p. $3.25. Longmans, Green, and Company, Inc., 119 West 40th St., New York 18, N. Y. 1960.
"A Rapid Journey Through the History of Physics" could be the subtitle of this book. It gives its readers an excellent trip from the science of Aristotle to the latest work on subnuclear particles via Newton, Einstein, and other giants of physics. Illustrated with excellent drawings, graphs, and descriptions of the most outstanding experiments in the development of physics, this book makes good reading for any high school student who has an average background in physics and mathematics, and might be considered a must for the college freshman. The well-developed and full bibliography offers excellent reading for those who would like to delve deeper into specific areas of physics.

The Living Laboratory—200 Experiments for Amateur Biologists. James Donald and Rebecca Hutto Witherspoon. 256p. $3.95. Doubleday and Company, Inc., 575 Madison Ave., New York 22, N. Y. 1960.
An interesting volume containing 200 projects and experiments that should be an aid to the high school student and the science teacher. Such topics as "Studying the Motion of Blood Cells," "The Testing of a Frog for Space Flight," and "The Care and Handling of Frogs and Mice" are discussed. The development of growing animals from embryos is discussed and many other useful and stimulating experiments of interest to all amateur scientists. A useful volume for the high school library.

Friction All Around. Tillie S. Pine and Joseph Levine. 48p. $2.50. McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y. 1960.
One of a series of books on scientific subjects. Topics discussed include: What makes things wear away? Does friction make things hot? Do we want things to slide and slip? How can we make electricity by rubbing? Provides examples (with illustrations) of friction and explanations of why it works. Provides motivation for reader experimentation. Develops awareness of scientific environment. Suitable as a reference book for elementary classes.

The Atom and Its Nucleus. George Gamow. 154p. $1.95. A Spectrum Book. Prentice-Hall, Inc., Englewood Cliffs, N. J. 1961.
An impressive, concise, and highly readable book that encompasses the major ideas concerning the atom beginning with early Greek philosophy and continuing to current frontiers of nuclear investigations. This up-to-date presentation is nonmathematical but satisfying to the serious reader. Recommended for students of high school chemistry and physics, nonscience college students, and adults.

The Nature of Violent Storms. Louis J. Battan. 158p. 95¢. Anchor Books, Doubleday and Company, Inc., Order from Wesleyan University Press, Inc., Columbus 16, Ohio. 1961.
Scientific observation of meteorologists is combined with eyewitness accounts of survivors who vividly describe thunderstorms, tornadoes, hurricanes, and cyclones. The book gives an elementary introduction to the known forces causing such storms. More adequate explanations and predictions are projected into the future through use of radar, electronic computers, and satellites such as Tyros I and Tyros II. Recommended for junior and senior high school students and general adult readers who are interested in these important and rapidly growing areas of research.

Elements of Physics. Third Edition. George Shortley and Dudley Williams. 928p. $10. Prentice-Hall, Inc., Englewood Cliffs, N. J. 1961.
A thorough reorganization and revision of a widely used introductory college physics text for science and engineering students who are concurrently enrolled in calculus. Major revisions when compared with the second edition are: (1) Integration of modern physics throughout the text; (2) Increased emphasis placed upon wave motion; (3) Inclusion of additional timely topics; and (4) A marked improvement in the illustrations.

NSTA Teaching Materials Review Committee

The Teaching Materials Review Center is located on the campus of Pennsylvania State University under the chairmanship of H. Seymour Fowler. The purpose of this joint project between NSTA and Pennsylvania State University is to continue reviews and reports on teaching materials used in elementary and secondary school science programs. The materials will include books, films and filmstrips, tape recordings, charts, laboratory apparatus and equipment, and related items.

Readers, suppliers, and publishers are encouraged to send correspondence or materials directly to DR. H. SEYMOUR FOWLER, College of Education, Pennsylvania State University, University Park, Pennsylvania.

Chairman Fowler will be assisted by committee members as follows: Dorothy Alfke, George Free, Andrew Kozak, and Burton Voss of Pennsylvania State University, University Park, Pennsylvania; Wilbur Gilham, Philipsburg High School, Philipsburg, Pennsylvania; Hugh Hodge and Robert Nelson, State College Junior High School, State College, Pennsylvania; Alan Humphreys, University of Texas, Austin, Texas; Robert Igo, Ferndale-Dale High School, Johnstown, Pennsylvania; Robert Isenberg, Altoona High School, Altoona, Pennsylvania; Herman Kranzer, Temple University, Philadelphia, Pennsylvania; Daniel Tauber, Bel Air High School, Bel Air, Maryland; Henry Terry, Armstrong High School, Richmond, Virginia; B. Jean Wastler, West Frederick Junior High School, Frederick, Maryland; and Lee E. Wickline, Department of Education, Charleston, West Virginia; and NSTA staff members.

Plague Fighters. Herman Styler. 142p. $3.50. Chilton Company, Book Division, Philadelphia 39, Pa. 1960.

Plague Fighters is an interesting and fascinating book which gives an account of the age-old struggle against diseases that man has had to contend with throughout history. Accounts of such struggles as the Athenians' fight against the Bubonic Plague, and Philadelphia's war against yellow fever are vividly portrayed. "Plague Fighters" depicts man in his constant struggles against greed, selfishness, and discouragement from very early history up to the modern accomplishments of Dr. Jonas Salk and the World Health Organization. Recommended for high school biology classes.

Great Ideas of Modern Mathematics: Their Nature and Use. Jagjit Singh. 312p. $1.55. Dover Publications, Inc., 180 Varnick St., New York 14, N. Y. 1959.

Dr. Singh covers the major mathematical ideas invented during the past two hundred years. He writes smoothly and brings out his points by the aid of a wide knowledge of nonmathematical fields. Most teachers with a sound high school mathematics training can read this excellent volume with interest and understanding. As library material, it should be on the desk of every high school mathematics and science teacher. Such topics as (1) the nature of mathematics (2) the theory of sets (3) chance and probability (4) the theory of groups and (5) space and time will help secondary teachers in the sciences and mathematics acquire and understand the "modern" mathematics which has received so much attention. As Dr. Singh points out, "the mathematics used 'today' is not always difficult, but it is often unfamiliar, even to people who have had some mathematical training at the university level." Good reading for the science teacher.

Let's Explore Chemistry. Nathan Feifer. 128p. $1. Sentinel Books Publishers, Inc., 112 East 19th St., New York 3, N. Y. 1960.

The simple how and why of chemistry developed through 200 safe experiments. The basic ideas are developed in a simple but logical manner with experiments to illustrate the vital concepts. Many pieces of household equipment are used while explaining everyday phenomena through experiments of general interest to the nonspecialist who is not ready to go deeply into chemistry.

Introduction to Electronics. Robert J. Hughes and Peter Pipe. 422p. $3.95. A Tutor Text. Doubleday and Company, Inc., 575 Madison Ave., New York 22, N. Y. 1961.

An intriguing and self-motivating programmed introduction to basic electronics via the scrambled text. Written for the inexperienced in electronics. Discusses DC circuits, AC electricity, and the basic components used in electronics. Concludes with tuned circuits, triodes, and a triode-plate detector. Uses simple arithmetic and algebra. Suitable for ages 14 and over as a "first" book for those interested in obtaining an understanding of basic electronics.

Physics for Everybody. Germaine and Arthur Beiser. 184p. $1.15. E. P. Dutton and Company, Inc., 300 Fourth Ave., New York 22, N. Y. 1960.

A simple and concise introduction to physics. Major areas of physics from matter and force to cosmic rays are surveyed. The treatment is completely nonmathematical although an occasional relationship is stated in algebraic form. Suitable as a "first" physics book for junior high school students, nonscience high school students, and general adult readers.

Natural Selection and Heredity. P. M. Sheppard. 200p. $1.35. Harper and Brothers, 49 East 33rd St., New York 16, N. Y. 1960.

A book from the Harper Torchbook Science Library. Chapter headings include: Natural Selection, Mendelian Principles, Polymorphism, Stable Polymorphism, Polygenic Inheritances and Selection, Recombination, Mutation and Genetic Drift, the Evolution of Dominance, Protective Coloration, Mimicry, Ecological Genetics, and the Origin of Species. Presents an historical background of evolution and an account of the most recent work in the field. Examples, largely from the Lepidoptera, are used to

illustrate how natural selection functions as a mechanism of evolution. A good reference book for the biology teacher.

Heath Science Series for Grades 1-8. Herman and Nina Schneider. D. C. Heath and Company, 285 Columbia Ave., Boston 16, Mass. 1960-61.
Science For Work and Play. Book 1. 154p. \$2.44. *Science For Here and Now*. Book 2. 210p. \$2.68. *Science Far and Near*. Book 3. 282p. \$2.92. *Science In Your Life*. Book 4. 304p. \$3.08. *Science In Our World*. Book 5. 330p. \$3.16. *Science For Today and Tomorrow*. Book 6. 362p. \$3.32. *Science In The Space Age*. Book 7. 362p. \$3.44. *Science and Your Future*. Book 8. 402p. \$3.72.
These books collectively describe a good elementary school science program. They are written by authors who know both children and science. Certain characteristics become evident when one reads the books. The authors have developed science concepts using an expanding pattern from grades 1 through 8. The books contain a wealth of "things to do" in science. They are not reading texts alone. Authors have found a way to include information from the biological, physical, and earth sciences. Teachers' editions are available. Color illustrations excellent and well chosen. Highly recommended for consideration as a complete series for grades 1-8. However, each text may be adopted and be the basis for a good science program in that grade.

The Atomic Submarine—A Practice Combat Patrol under the Sea. Russell Hoban. \$2.50. Harper and Brothers, 49 East 33rd St., New York 16, N. Y. 1960.
Begins with a statement of the limitations of the conventional submarine. The advantages of the atomic submarine are given including the small amount of fuel used by the reactor, the great distance traveled without refueling, the ability to stay submerged for long periods of time, and the increase in speed. The reader is carried on a practice combat patrol in the submarine. Some of the explanations given are: how the submarine submerges and returns to the surface; and how it makes contact with, approaches, and torpedoes a simulated enemy vessel. The book is well illustrated with drawings which give the reader a conception of the interior of a submarine.

All About Great Medical Discoveries. David Dietz. 140p. \$1.95. Random House, Inc., 457 Madison Ave., New York 22, N. Y. 1960.
One of the "All About" series. Chapters are interesting stories: stone age man's beliefs; the Egyptian doctor, Imhotep; the first Greek physician, Asclepios; and men like Hippocrates, Galen, Vesalius, Harvey, Auenbrugger, Leeuwenhoek, Pasteur, and Koch are introduced with their contributions to medical knowledge. Techniques of development and use of vaccination, antiseptics, innoculations, the sulfas, penicillin, and other drugs along with how problems of polio and smallpox were solved, make this volume a valuable addition to upper grade, junior high, and high school libraries. Recommended for health classes and general science classes. Index includes pronunciation of medical terms. Vocabulary is well chosen for grade level recommended.

Engineers and What They Do. Harold Coy. 186p. \$3.95. Franklin Watts, Inc., 575 Lexington Ave., New York 22, N. Y. 1961.
A worthwhile contribution to the professional and vocational guidance of science students. Gives realistic answers to questions such as: What courses should a high school student take to become an engineer? What is the cost of college training? How can one finance it? What courses are taken in college? Where may one obtain career booklets? What job opportunities are available? Suggested as required reading for all high school students who have aptitudes and interests in engineering.

Style Manual for Biological Journals. Committee on Form and Style of the Conference of Biological Editors. 92p. \$3. American Institute of Biological Sciences, 2000 P St., N.W., Washington 6, D. C. 1960.
An excellent aid to all prospective authors, especially those intending to submit manuscripts to the biological journals. Contains

instructions on writing, copy preparation, review of manuscripts, copy editing, proofreading, and indexing. In addition, a number of reference works are given, as well as a complete index. Already adopted, in whole or in part, by 78 journals including the *American Biology Teacher*. Because of its wide acceptance, this manual will bring more uniformity in standards required by the various journals. Illustrated.

The Astronauts. Martin Caidin. 192p. $3.95. E. P. Dutton and Company, Inc., 300 Park Ave., South, New York 10, N. Y. 1960.
A volume in which the opening chapters, The Launching, and Mission in Orbit, create for the reader a sense of interest and anticipation. By this approach, technical terms are introduced without overwhelming the layman. All areas of the astronauts' project are well explored with accompanying detailed drawings and photographs. A workable sequence covering a difficult field. Recommended to high school students and to those persons having an interest in our scientific achievements.

Breakthroughs in Science. Isaac Asimov. 198p. $4. Houghton Mifflin Company, 2 Park St., Boston, Mass. 1960.
From the ancient cry "Eureka" to modern-day countdown, from Leeuwenhoek to Einstein; this book includes a mixture of brief biographical sketches of important individuals in chemistry, physics, astronomy, biology, medicine, and genetics—26 in all. Informative and interesting for the upper elementary and junior high levels.

Archeologists and What They Do. Robert J. Bradwood. 176p. $3.95. Franklin Watts, Inc., 575 Lexington Ave., New York 22, N. Y. 1960.
A volume of a series describing various careers. Explains in rather complete detail the different activities of the archeologist. Covers the various phases of archeology. Gives detailed descriptions of the techniques of discovery and classification of antiquities. Good book for serious-minded junior high student; not an adventure story in the classic sense.

The Story of Horses. Dorothy Shuttlesworth. 58p. $2.95. Doubleday and Company, Inc., 575 Madison Ave., New York 22, N. Y. 1960.
The book traces the evolution of the horse from the earliest ancestor, Eohippus, to the true horse; points out the migrations of the prehistoric horses; and explains man's controlled breeding of the various types of horses in order to obtain animals with the desired characteristics. (Terms used in the description of horses included.) Explanation of the changes that take place in a horse's mouth with age, and the movement of the limbs of a horse when walking, running, and jumping are given. It is also pointed out that few really wild horses exist today and why. Behavior of horses in herds and horse families such as the zebras and the wild asses of Africa are mentioned. The origin and characteristics of the modern horse are described. These are divided into two groups, the "Light Legged" Group and the "Draft" Group. The "Light Legged" Group includes the Arabian Horse, the Barb of North Africa, the Thoroughbred, the American Saddle Horse, the Tennessee Walking Horse, the Standardbred, the Morgan, and the Quarter Horse. The "Draft" Group includes the Percheron of France, the Belgian of Belgium, and the Clydesdale, Shire, and Suffolk of the British Isles. Other animals included are the Palomino, the Pinto, the Appaloosa, Ponies, and the Mule.

PROFESSIONAL READING

"New Penicillins." By Anthony H. Rose. *Scientific American*, 204:66. March 1961. Penicillin-resistant strains of bacteria produce enzymes which destroy the penicillin molecule. Chemists have learned how to grow the mold, *Penicillium*, in media which cause development of side chains on the penicillin molecule preventing its breakdown.

"Teaching Anthropology in High School." By Robert L. Dunlap. *The Education Digest*, 26:52. April 1961. A course in anthropology for the secondary school curriculum is not common. This article is a treatise of such an experimental venture in an appropriate locale. It includes reasons, research, aims, procedures, and achievements to date for the course. Excellent suggestions for senior high school science teachers.

"The Fourth Dimension in Science Education." By L. D. Kovach. *Physics Today,* 14:48. March 1961. Should scientists "put on blinders" to their entire field of interest and specialize? In order to teach effectively, the teacher must not be a specialist, but must be a generalist in the area of science. What type of techniques must teachers employ to teach the entire area of science? The article presents "the fourth dimension" as an answer to these questions.

"Electrical Propulsion in Space." By Gabriel Gianni. *Scientific American,* 204:57. March 1961. Three electrical engines; the electricthermal, the electromagnetic, and the electrostatic, and how they can be used in space travel, are described. Comparisons are drawn between solid propellant, liquid propellant, and the electrical engine. In addition, the two main problems facing the developers of electrical propulsion systems are discussed. Photographs and diagrams are used throughout in explaining the field of electrical propulsion.

"The Philosophy of Physics." Edited by Vincent E. Smith. *St. John's University Studies.* St. John's University Press, Jamaica, N. Y. 1961. Four distinguished scholars have contributed essays for this publication. The essays are entitled, "The Unity and Diversity of Natural Science," "Maritain's Philosophy of the Sciences," "The Structure of the Atom," and "Does Natural Science Attain Nature or Only the Phenomena?" These essays are nonmathematical, qualitative descriptions that discuss the basic problems in physics. Such fundamental topics as the fundamental laws of atomic physics according to Bohr and Einstein are included.

"A Guess as to What Is Science." By Dan McLachlan, Jr. *Physics Today,* 14:22. June 1961. The basis for this article is a statement by a college professor, "I wish there was some way to make a science out of geology." The stages in the growth of a science, the influence of the sciences on each other, and the procedures for making discoveries are among the topics discussed. A thorough explanation and exemplification of the term "discovery" are included.

"Gravity." By George Gamow. *Scientific American,* 204:94. March 1961. Many theories about gravity are explained. The fact that the force resulting from gravity is not duplicated in electricity and magnetism is explored. Einstein's contribution to the understanding of gravity, *i.e.,* gravitation can be thought of as a geometrical property of space-time, is fully described. Discussed are the centrifugal field of force, the curvature of light, and gravity waves.

"The Remaking of American Education." By Charles E. Silberman. *Fortune,* 63:31. April 1961. Modern culture is requiring changes in education aimed at producing "masses of intellectuals." Now the emphasis in education is not on learning skills, which obsolesce, not on learning facts, which wear out, but on the knack of learning itself. To demonstrate these ideas, Silberman points to new trends in curricula using the Physical Science Study Committee program and the School Mathematics Study Group as examples. He also discusses new curricular patterns in other academic areas and surveys the latest thinking of many leaders.

"The Temperatures of the Planets." By Cornell H. Mayer. *Scientific American,* 204:58. May 1961. New techniques in measuring surface temperature of the other planets in the solar system are described. Weak radio waves emitted by the various planets can be interpreted to give estimates of surface temperatures. Each planet is in thermo equilibrium and therefore must radiate energy as fast as it receives it from the sun. The radiated energy is detected by new tools of radio astronomy such as the radiometer and solid-state maser.

"18 Questions and Answers about Radiation." United States Atomic Energy Commission. 48p. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 1960. This recent publication answers eighteen of those most commonly asked questions. The pamphlet is written in a brief, nontechnical style. Such questions as, "What Is Nuclear Radiation?" "Where Does Radiation Come From?" and "What Are the Natural Sources of Radiation?" are discussed. Diagrams and charts are used as an integral part of the explanation. Copies available from the GPO for 25¢ each.

"A Treaty for Antarctica." By Howard J. Taubenfeld. International Conciliation, 531, Carnegie Endowment for International Peace, United Nations, Plaza and 46th St., New York 17, N. Y. January 1961. "The most important present . . . use of the Antarctic is the one so brilliantly made during the International Geophysical Year—the

gathering of scientific knowledge of benefit to all." This quote from the pamphlet sets the tenor for its purpose. During the IGY, twelve nations worked together to investigate scientific phenomena. The pamphlet explains the unique factors that have made agreement possible between scientists in order to keep the Antarctic open to all nations for scientific and other peaceful purposes. The agreement reached among the scientists is presented as a precedent for similar agreement on such topics as outer space and disarmament.

"Science as a Way of Life." By Ellsworth S. Obourn. 25¢. U. S. Government Printing Office, Washington 25, D. C. 1961. Pamphlet emphasizes how science has affected man's progress and his behavior. It also shows that science has many facets by using such phrases as, "Science is a subtle thing: It is part product and part process, part control, and part understanding." Today's adults do not generally use the concepts of science in their daily living because, according to the author, these concepts were learned apart from the processes of science that established them. The pamphlet concludes with a suggested check list for a school science program. Available for 25¢ from the GPO.

AUDIO-VISUAL AIDS

The Importance of Microorganisms. Film No. 12 in Part II of the American Institute of Biological Sciences series of secondary school biological sciences films. Film is a summary of the second unit of the AIBS series and, as such, includes the impact of microorganisms in relation to human welfare. Major topics include: the nitrogen cycle, the role of bacteria in decomposition, pathogenic organisms, and microorganisms in medicine. This lecture-demonstration film introduces a wide variety of organisms that are generally not available in high school. Recommended for use with the series or as a summary for a unit on microbiology, not as an introductory film. 24 min. Cost depends on the number of films purchased. Price range: Less than one unit; Color $300, B&W $150. If nine to ten units purchased, range down to Color $220, B&W $110. McGraw-Hill Text Films, 330 West 42nd St., New York 36, N. Y.

Student Nurse. An excellent guidance film. Shows girls in training as student nurses, their concerns, and their sincere interest which overcomes their fears. Weaves in an interesting story of the capping ceremony and the difficulties encountered in completing additional, more advanced training. Illustrates instruction in many nurse's subjects such as anatomy, physiology, bacteriology, nursing arts, and pharmacology. Nurses who view this film state that it is "true to life." Appropriate for career information days in senior high school. Might also be useful in biology classes as an example of biology career information. 30 min. Color $125. 1960. Produced by National Film Board of Canada. Distributed by International Film Bureau, Inc., 57 East Jackson Blvd., Chicago 4, Ill.

Infectious Diseases and Man-Made Defenses. Louis Pasteur's discovery of the cause of infectious diseases. The ability of scientists to develop man-made defenses against them, such as the pasteurization of milk and the chlorination of water. Man's inner and outer defenses against disease. Explanation given of naturally and artificially acquired immunity, what toxins and antitoxins are, and how antitoxins provide passive immunity, what vaccines are and how they provide

active immunity, the preparation of diphtheria antitoxin and the vaccines for smallpox and influenza. The film also shows recent advances in antibiotics, such as penicillin and synthetic drugs. For junior and senior high school. Film holds interest well. Superimposing of some of the terms and of their definitions on the screen is helpful to the pupils. 11 min. Color $110. 1960. Coronet Films, Coronet Building, Chicago 1, Ill.

The Life and Death of a Cell. A carefully edited and well-programmed film illustrating the life processes of a one-celled animal; the amoeba. Anatomy of an amoeba is considered by complete diagrams and illustrations from the living organism. Second half of film portrays the various life functions of the amoeba, including digestion, egestion, water balance, irritability, movement, and cell division. These are clearly shown through time-lapse photography. Useful film for senior high biology. 21 min. Color $195. 1961. Education Films Sales Department, University Extension, University of California, Los Angeles 24, Calif.

The World Within. An intriguing film that deals with the topic of parasites and parasitology. Begins with the history of the men in parasitology and their discoveries. Through the process of animation and examples from life studies, the film defines the various forms of animal association; such as, symbiosis, mutualism, commensalism, and parasitism. Types of parasites are considered: plant, animal, fungus, bacterial, and virus. Emphasizes animal parasites. Excellent for senior high biology students. 28 min. Color $195. 1960. Educational Film Sales Department, University Extension, University of California, Los Angeles 24, Calif.

Discovering Color. A film in color which makes possible a natural integration of science and art. Demonstrates techniques of color mixing and explores color in its great variety as it is found around us in the real world. Concentrates on the three basic concepts of (1) hues, (2) value, and (3) intensity. Includes following vocabulary; spectrum primary hues, secondary hues, basic hues, value, intensity, complementary hues, warm hues, and cool hues. Recommended for elementary and junior high levels in art programs. Would, no doubt, be of value to many adult audiences. 15 min. Color $160. 1960. Film Associates of California, 11014 Santa Monica Blvd., Los Angeles 25, Calif.

Television Serves Its Community. Shows how television programs are prepared for transmission to the homes. The film describes the tremendous amount of work and accurate timing that goes into a program. The viewer is made aware of the expense involved in equipment such as cameras, films, magnetic tapes, etc. The viewer sees a live program, a top program, film program, and remote pickups. Grades 6-10. 16 min. Color $135, B&W $70. 1960. Film Associates of California, 11014 Santa Monica Blvd., Los Angeles 25, Calif.

Letter from Alaska. The film opens with a winter trip up the Alaska Highway to Anchorage. Pictures of a carnival in Anchorage include dog-sled racing, Eskimo folk dancing, and a ball game on snowshoes. Summer scenes show bathing and street scenes such as are found in a typical city on the mainland. A modern school is shown. The historical background of Alaska is given, prior to its statehood including time of discovery, purchase by the United States, and the gold rush. Interesting pictures of the topography of Alaska include the Katmai volcanic area, the Valley of 10,000 Smokes, high rugged mountains including Mount McKinley, glaciers, moraines, formation of icebergs, the tundra, and rivers. Pictures of

wildlife includes bears, moose, caribou, fox, and some fish. Industrial development is shown through gold and tin mining, the Alaska Railroad, hydroelectric plants, fishing fleets, logging operations and a large pulp mill. Scenes showing life on farms are included. Would probably be of greater use in social studies. However has appropriate science material. For upper elementary and junior high, also for adult groups. 20 min. Color $195. 1960. Northern Films, Box 98, Main Office Station, Seattle 11, Wash.

The Classification of Birds. These Kodachrome slides made from the paintings of William C. Dilger show the external features which distinguish each of the seventy-five North American bird families. Includes single detailed superb photographs of a typical member of each bird family. The slides might serve as a substitute for a synoptic-skin or mounted-bird collection. Other sets available include: *Birds of House and Garden, Birds of Woods and Fields, Birds of the Marshes, Breeding Cycle of Birds, Coloration of Birds, North American Shore Birds,* and *Natural History of the Waterford.* Recommended for high school biology and college classes in the biological sciences, particularly ornithology. The Classification of Birds—Kodachrome Slides. 175 slides (2" x 2"). $111. 1960. (Individual single slides may be purchased also.) David G. Allen, 23 Sapsucker Woods Road, Ithaca, N. Y.

NSTA CALENDAR

As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to *TST's* calendar editor as early as possible.

September 3-8, 1961: American Chemical Society, 140th National Meeting, Chicago, Illinois

September 4-5, 1961: NSTA Regional Conference, Oklahoma State University, Stillwater, Oklahoma

September 8-9, 1961: NSTA Regional Conference, University of North Carolina, Chapel Hill, North Carolina

September 22-23, 1961: NSTA Regional Conference, University of Nebraska, Lincoln, Nebraska

September 28-30, 1961: NSTA Regional Conference, Vocational High School, Minneapolis, Minnesota

October 6-7, 1961: NSTA Regional Conference, Bradford Hotel, Boston, Massachusetts

October 13-14, 1961: NSTA Regional Conference, Sheraton Hotel, Portland, Oregon

October 20-21, 1961: NSTA Regional Conference, Netherland Hilton Hotel, Cincinnati, Ohio

October 26-27, 1961: Association for the Education of Teachers in Science, Annual Fall Regional Meeting, Columbia University, New York City

November 5-11, 1961: American Education Week, Theme: Your School—Time for a Progress Report

November 23-25, 1961: 61st Annual Meeting, Central Association of Science and Mathematics Teachers, Sheraton Chicago Hotel, Chicago, Illinois

December 26-30, 1961: NSTA Annual Winter Meeting in conjunction with 128th meeting of the American Association for the Advancement of Science, Denver, Colorado

January 24-27, 1962: Annual Meeting, American Association of Physics Teachers, Statler-Hilton Hotel, New York City (Joint meeting with the American Physical Society)

February 21-24, 1962: 35th Annual Meeting, National Association for Research in Science Teaching, Willard Hotel, Washington, D. C.

March 9-14, 1962: NSTA Tenth Annual National Convention, San Francisco, California

April 15-18, 1962: 40th Annual Convention, National Council of Teachers of Mathematics, Jack Tar Hotel, San Francisco, California

APPARATUS & EQUIPMENT

The Recording Timer Kit, No. 2200. Part of the PSSC equipment. The recording timer is adapted from an ordinary doorbell. It is used for making time interval marks on a tape pulled under a piece of carbon paper struck by the doorbell clapper. As a demonstration, the timer may be used in the calculation of the gravitational acceleration constant. A tape is pulled through the timer by means of attaching it to a weight which is allowed to fall from a height of about seven feet. The Macalaster Bicknell model is a definite improvement over some former models in several respects. The staples employed as tape guides make for less manipulation in the feeding of tape; also a circular disc carbon-paper arrangement simplifies feeding so that no manual feeding is necessary. Some difficulty was experienced in determining the time interval using the hand operated strobe disc because of the frequency of vibration of the clapper operated by a 1½-volt dry cell. Two possible methods for alleviating the condition are: (1) to use a small variable resistor in the circuit to control the frequency; (2) to drill a hole in the extreme end of the clapper and fit with a small, flathead machine bolt to which one or more nuts might be fastened to slow the rate of vibration. A clothespin clipped to the end of the clapper is another effective means of reducing the rate. $2.25. Macalaster Bicknell Corporation, 253 Norfolk St., Cambridge 39, Mass.

The Electrostatics Kit, No. 1000. Part of the PSSC equipment. This kit contains the necessary assortment of materials to produce electric charges, apply them to objects under test, and to insulate adequately charged objects and position them for examination. Two types of plastic strips with rubbing cloths yield positive and negative charges. The cloths are somewhat difficult to identify; a spot of dye on one of them would make identification easier than the "by the feel" method suggested. A graphite paint is included (for coating the pith balls) to assure a uniform charge. The pith balls are suspended by nylon filaments or supported on plastic insulator sticks with clothespin bases. The latter arrangement makes possible the quantitative measurements required in the second group of PSSC experiments. The first group of two experiments is that of the conventional qualitative type. Kit is designed for use by an entire class (about 24 students) providing an economical means for supplying necessary equipment. $9.50. Macalaster Bicknell Corporation, 253 Norfolk St. Cambridge 39, Mass.

The Hand Stroboscope, No. 2700. One of the devices in PSSC equipment. Little need be said concerning the stroboscope disc except that it virtually duplicates the twelve-slit "masonite" disc previously available. It is easily assembled, sufficiently sturdy, and entirely adequate for the purpose for which it is intended: measurement of short-time intervals and the study of periodic waves in the ripple tank. One stroboscope for each two students in class is recommended. 85¢. Macalaster Bicknell Company, 253 Norfolk St., Cambridge 39, Mass.

Collision in Two-Dimension Kit. What happens when two objects collide? Kit was designed to give an answer. Intended for PSSC experiments. Illustrates how momentum is conserved in a collision; and in the case of a perfectly elastic collision, how kinetic energy is conserved. Equipment includes: two small steel balls, a lighter glass

ball, and a track on which to roll the balls. Marks on carbon paper show the motions after the collision. Laboratory manual supplies experimental procedure permitting a class to gather enough information during one double laboratory period to keep busy for several days. They can investigate momentum and kinetic energy distribution in elastic head-on and oblique collisions involving equal and unequal masses. Application of the results to modern nuclear physics, such as the scattering of photons by electrons, would be an appropriate and excellent follow-up to such a study. Two kits recommended for each four students. Catalogue No. 400. $1.65. 1960. Macalaster Bicknell Corporation, 253 Norfolk St., Cambridge 39, Mass.

Starfinder-Celestial Globe. A valuable tool to gain an understanding of the apparent motions of the sun, planets, and stars. Identifying stars and recognizing constellations become easier by visualizing them on a sphere. Teachers of earth and space science courses will find this globe a great asset. The dark blue background makes the stars, constellations, and other markings stand out well and not seem cluttered. The plastic finish allows crayon marking. Plotting of planets, sun, moon, and earth satellite positions is simplified. A brief manual is included which describes the simple practical use of the globe. Produced by Rand McNally. $19.95. Edmund Scientific Company, 101 East Gloucester Pike, Barrington, N. J.

Sundial. This sturdy, attractive, bronze sundial would be a decorative asset to any school yard, as well as a tool to study time and the apparent movement of the sun. It is 13½ inches in diameter with its face showing sun-fast and sun-slow corrections plainly. The gnomon is securely attached. Detailed instructions for orienting the dial and constructing a base are included. Useful apparatus in elementary instruction. $10. Edmund Scientific Company, 101 East Gloucester Pike, Barrington, N. J.

Index of Advertisers

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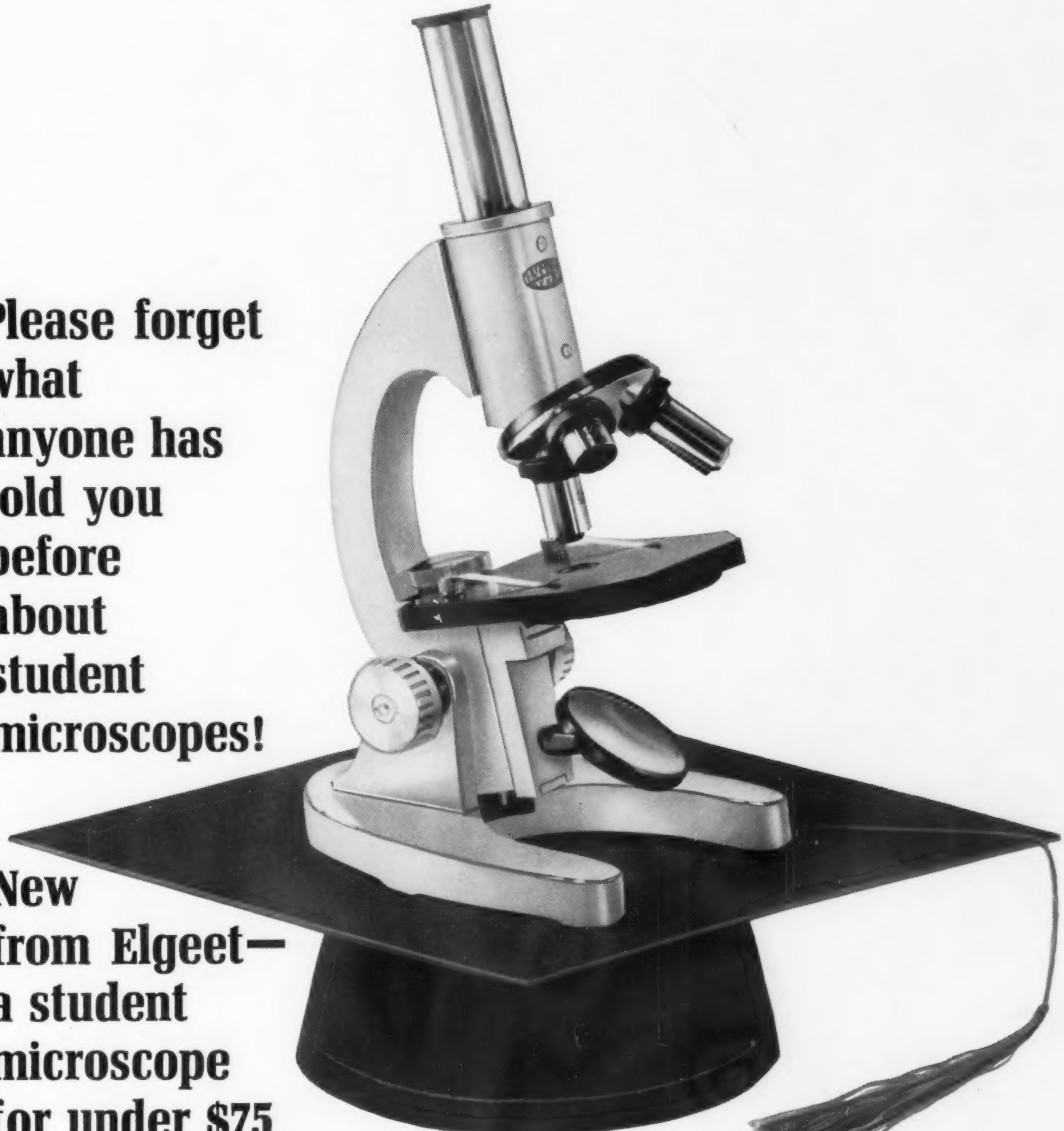

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